WASHINGTON STATE DEPARTMENT OF
Natural Resources

Restoration of Lost Corners, Subdivision of Sections, and Local Establishment of Original Corners

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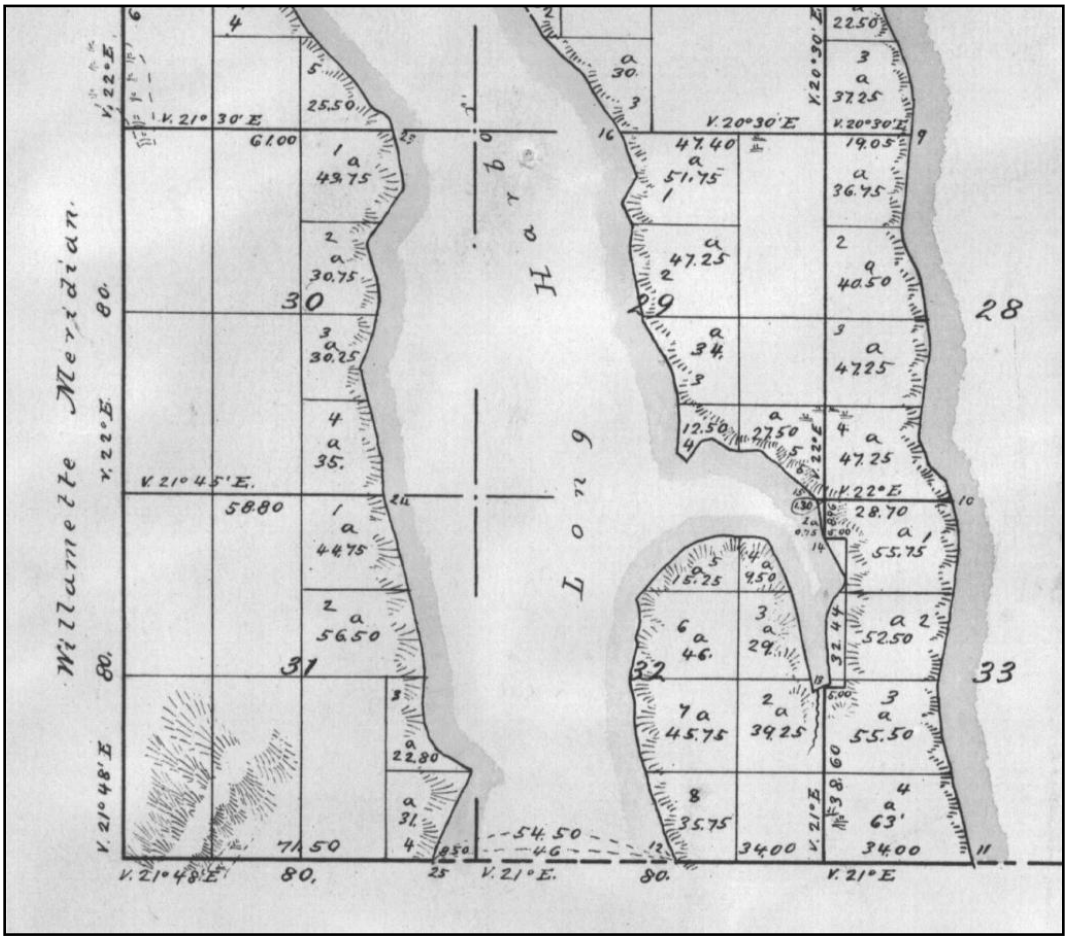

Preface

This document is meant to be a reference for the procedures used in the resurveys and subdivisions of sections of the public land surveys in the United States, particularly in the State of Washington. The examples are from Washington and some of the principles of survey have been derived from opinions of the BLM office in Portland, Oregon.

The system of public land surveys was devised for the purpose of efficiently settling and selling the lands of the public domain of the United States extending across the North American continent. The federal surveys did not establish all the boundaries and corners for each separate parcel of land granted by the government; they established a grid of surveyed lines and corners of sufficient detail to enable purchasers and other owners of formerly public land to locate the corners and lines of their parcels. Subsequently, county and local surveyors were given the responsibility to establish many of the original corners of the lands granted by the federal government.

The procedures outlined here are intended to help produce well-grounded surveys of federally disposed parcels that have corners missing either because the locations of the original corners have been lost or because the corners have not yet been established. Finding the original lines and corners is a responsibility of a land surveyor. If a previously established corner or line is not visible on the ground, the surveyor should try to find evidence of the corner or line. Only after exhaustive examination and research can a conclusion be reached that the corner or line is lost. Even if there is no record that a corner or line has been previously established the surveyor should search for any evidence of the corner or line having been previously established. If such evidence exists he should uncover the facts and apply the rules and principles of acceptable corner evidence before concluding that the corner or line is missing or lost. A missing corner must be established using either the principles for the restoration of lost corners or the principles for the establishment of original corners.

The diligent retracement of previous surveys will avoid unnecessary harm to the stability land boundaries. Only when the retracement is unsuccessful or the survey has not yet been made can the procedures outlined here be applied.

A. C. Mulford, in his 1912 book, Boundaries and Landmarks, points out the importance of retracing the original survey. His observations, though directed to the surveyor of lands described by metes and bounds, apply equally to resurveys in the public land survey system.

> *The training of the surveyor consists essentially in practice in turning angles, measuring lines and getting over obstructions, to which are added rather meager suggestions on the subjection of the compass and the re-running of old surveys. He is considered preeminently a measurer of land. This is very true, and in certain localities and under certain conditions this may compose almost the entire work of the surveyor. But in the vast majority of cases the actual measuring of land forms the smaller portion of his duties. His hardest*

work is often, to use a colloquial phrase, to "find the land" to be surveyed.

Perhaps, as time passes, the accumulation of documented surveys and the decline in the number of corners and lines that have never been established will make this document less of practical value and more of historic interest.

The U.S. Bureau of Land Management (BLM) and its predecessor, the General Land Office (GLO), have long published manuals, pamphlets and circulars that cover the topics of this document, which is not meant to compete with those authoritative sources but is intended to provide additional guidance concerning certain practices and procedures. This document should be consulted jointly along with a study of relevant GLO and BLM documents, especially chapters 3 and 5 of the BLM 1973 *Manual of Surveying Instructions* and the 1974 edition of the BLM pamphlet, *Restoration of Lost or Obliterated Corners & Subdivision of Sections*.

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I. Brief History of the Laws of the Rectangular Survey System[1]

The United States, shortly after independence, began disposing of areas of public land. The Land Ordinance of 1785, *An Ordinance for Ascertaining the Mode of Disposing of Lands in the Western Territory*, passed May 20, 1785, was the first of several legislative acts that created the Public Land System and the Rectangular System of Surveying. Thomas Jefferson headed a committee to draft the ordinance which, in its original form, proposed the creation of tracts of land 10 miles square, called "hundreds," composed of 100 lots of one square geographical mile. After Jefferson was sent to France to negotiate commercial treaties with European countries, and William Grayson replaced him as committee chair, and various alternate proposals of 7 and 6 mile square townships, it was settled by the ordinance that the unit of land would be the township, 6 miles square, with townships alternating between being whole and being composed of 36 lots of one square mile. Every Lot 16 was set aside for the maintenance of public schools. The minimum price was set a $1 per acre, and the cost of survey, to be borne by the purchasers, was set at $36 per township. The Geographer of the United States, Thomas Hutchins, was directed to appoint surveyors to divide the Western Territory into townships.

The basis of bearings for public land surveys was established as true astronomic by the Land Ordinance of 1785.

> *"The surveyors, as they are respectively qualified, shall proceed to divide the said territory into townships of six miles square, by lines running due north and south, and others crossing these at right angles, as near as may be."*

The Act of May 18, 1796, created the office of Surveyor General and set a method by which townships were to be subdivided. The Act was the first to call the square mile lots "sections" and prescribed the current numbering system with section one in the northeast corner of the township. The Act directed that half of the townships would be sold by the quarter township with no interior lines having been surveyed. The other half of the townships would be subdivided by running parallel lines through the township at the end of every two miles, with section corners established at every mile on the lines surveyed. The result was a survey of a township into nine blocks of four sections, with all of the section corners on the exterior having been established. The section corners not established by the method were the corners of 1, 2, 11 and 12, of 3, 4, 9 and 10, etc. Lines were to be measured with a chain containing two perches of 25 links each and adjusted to a standard chain.

The authority to write surveying rules and regulations was delegated to the Surveyor General by the 1796 Act.

1 Much of this material is taken from A History of the Rectangular Survey System by C. Albert White, published by the Bureau of Land Management.

Section 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a Surveyor General shall be appointed, whose duty it shall be to engage a sufficient number of skillful surveyors, as his deputies; ... he shall have authority to frame regulations and instructions for the government of his deputies.

Rufus Putnam was appointed as the first Surveyor General on October 1, 1796, and served until 1803.

The 1796 Act was amended by the Act of May 18, 1800, which specified that unsubdivided townships were to be subdivided by surveying lines every mile from east to west and south to north within the township, establishing all the section corners, but quarter corners established only on the east-west lines. Excess and deficiencies were to be placed on the north and west boundaries of the township and all sections except those on the north and west boundaries were to be declared to contain 640 acres.

In 1803 Thomas Jefferson replaced the Surveyor General, Rufus Putnam, with Jared Mansfield, a technically oriented man who had been a professor of mathematics at West Point military academy. Albert Gallatin, a Swiss emigrant, was Jefferson's Secretary of the Treasury and the supervisor of the Surveyor General. Jefferson, Gallatin and Mansfield were all technically and scientifically oriented, and these men insured that the surveys of the public lands would become more systematic and rigorously executed.

The Act of February 11, 1805, completed, in the main, the establishment of the Public Land System of Rectangular Surveys. The act is codified in Chapter 18 of Title 43 of the United States Code and is still the law of the land. The Act settled several basic principles of the subdivision of townships and sections.

(1) Corners and lines established by United States survey are to be held as correct and proper corners and lines. No subsequent survey could correct the corner position to place it more in conformity with the plan of survey.

(2) After an original survey, subdivisions are to be made by connecting opposite corners with straight lines. The method of quartering surveyed rectangular parcels like sections is to connect the midpoint corners on opposite sides of the figure.

(3) Where no such opposite corners exist, boundaries shall be made by running from established corners in a cardinal direction. Fractional sections and quarter sections, that do not have an opposite side midpoint, are to be subdivided by running cardinal.

(4) The corners of half and quarter sections, not marked by the original survey, shall be placed as nearly as possible equidistant from the two corners which stand on the same line. Quarter corners and other corners such as one sixteenth corners, which were not established by the federal survey, are to be established at midpoint.

(5) The acreage returned by United States survey shall be considered as exact. Acreages shown on the plat of survey are to be used for land dispositions and apportionment of unsurveyed corners.

Act of February 11, 1805

Chap. XIV-An Act concerning the mode of surveying the Public Lands of the United States. (a)

STATUTE II.
Feb. 11, 1805

Act of May 18,1796 Ch. 29. Mode of surveying public lands north of the Ohio.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the surveyor-general shall cause all those lands north of the river Ohio, which by virtue of the act, entitled "An act providing for the sale of lands of the United States, in the territory northwest of the river Ohio, and above the mouth of the Kentucky river," were subdivided, by running through the townships, parallel lines each way, at the end of every two miles, and by marking a corner on each of the said lines, at the end of every mile; to be subdivided into sections, by running straight lines from the mile corners thus marked, to the opposite corresponding corners, and by marking on each of the said lines, intermediate comers as nearly as possible equidistant from the corners of the sections on the same. And the said surveyor-general shall also cause the boundaries of all the half sections, which had been purchased previous to the first day of July last, and on which the surveying fees had been paid, according to law, by the purchaser, to be surveyed and marked, by running straight lines from the half-mile corners, heretofore marked, to the opposite corresponding corners; and intermediate corners shall, at the same time, be marked on each of the said dividing lines, as nearly as possible equidistant from the comers of the half section on the same line: Provided, that the whole expense of surveying and marking the lines, shall not exceed three dollars for every mile which has not yet been surveyed, and which shall be actually run, surveyed, and marked by virtue of this section. And the expense of making the subdivisions, directed by this section, shall be defrayed out of the monies appropriated, or which may be

Corners to be marked.

Half sections purchased before July 1, 1804, to be surveyed and marked.

Whole expense of survey not to exceed three dollars per mile.

How the expense of making the surveys is to be paid.

hereafter appropriated, for completing the surveys of the public lands of the United States.

Principles upon which the boundaries and contents of the public lands are to be ascertained.

Sec. 2. And be it further enacted, That the boundaries and contents of the several sections half sections, and quarter sections of the public lands of the United States, shall be ascertained in conformity with the following principles, any act or acts to the contrary notwithstanding:

lst. All the corners marked in the surveys, returned by the surveyor-general, or by the surveyor of the land south of the state of Tennessee, respectively, shall be established as the proper corners of sections, or subdivision of sections, which they were intended to designate; and the corners of half and quarter sections, not marked on the said surveys, shall be placed as nearly as possible equidistant from those two corners which stand on the same line.

Boundary lines run and marked by the surveyor south of the Tennessee River to be the proper boundaries of sections.

2d. The boundary lines, actually run and marked in the surveys returned by the surveyor-general, or by the surveyor of the land south of the state of Tennessee, respectively, shall be established as the proper boundary lines of the sections, or subdivisions, for which they were intended, and the length of such lines, as returned by either of the surveyors aforesaid, shall be held and considered as the true length thereof. And the boundary lines, which shall not have been actually run, and marked aforesaid, shall be ascertained, by running straight lines from the established comers to the opposite corresponding corners; but in those portions of the fractional townships, where no such opposite corresponding corners have been or can be fixed, the said boundary lines shall be ascertained, by running from the established corners, due north and south, or east and west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional township.

Boundary lines not actually run to be ascertained.

Surveys to be returned.

3d. Each section, or subdivision of section, the contents whereof shall have been, or by virtue of the first section of this act, shall be returned by the surveyor-general, or by the surveyor of the public lands south of the state of Tennessee, respectively, shall be held and considered as

containing the exact quantity, expressed in such return or returns: and the half sections and quarter sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one half, or the one fourth part respectively, of the returned contents of the section of which they make part.

Sec. 3. And be it further enacted, That so much of this act entituled "An act making provision for the disposal of lands in the Indiana territory, and for other purposes," as provides the mode of ascertaining the true contents of sections or subdivisions of sections, and prevents the issue of final certificates, unless the said contents shall have been ascertained, and a plot certified by the district surveyor, lodged with the register, be, and the same is hereby repealed.

Part of a former act repealed.
Act of March 26, 1804, Ch. 35.

APPROVED, February 11, 1805

The words of the Act of February 11, 1805, were soon seen to require interpretation.

On April 3, 1805, Surveyor General Jared Mansfield wrote to Secretary of the Treasury, Albert Gallatin, and discussed the Act of February 11, 1805. His primary concern was the subdivision of fractional townships. The second clause of Sec. 2 of the act said that fractional townships were to be subdivided by running due north and south or east and west from the corners to an intersection with the boundary, which made the township fractional. He advocated that this procedure wasn't proper unless the section boundaries were actually on a true cardinal bearing and that the subdivisional lines would have to be run *parallel to the established section boundaries or mean courses would have to be adopted*. This method of subdivision was adopted by Mansfield as following the intent of the law and is the present-day practice.[2]

Earlier, on March 13, 1805, Gallatin had written to Isaac Briggs, Surveyor of the Lands South of Tennessee, concerning the intent of the Act of February 11. His words make it clear that surveys were to be done in a practical manner and that the corners should remain fixed. Certainty of boundaries and corners was of paramount importance, with accuracy of surveys being inferior.

> *You will also perceive from the enclosed act that the principal object which Congress has in view is that the corners and boundaries of the sections & subdivision of sections should be definitively fixed; and that ascertainment of the precise contents of each is not considered as equally important. Indeed it is not so material either for the United States or for the individuals, that purchasers should actually hold a few acres more or less than their surveys may call for, as it is that they should know with precision, and so as to avoid any litigation, what are the*

2 From A History of the Rectangular Survey System by C. Albert White, page 56, with minor edits.

certain boundaries of their tract.

An Act of April 24, 1820, made provision for lands to be sold in areas as small as half quarter sections and made it explicit that the subdivision rules of the Act of February 11, 1805, apply to quarter sections also.

> *Be it enacted ..... and in every case of the division of a quarter section, the line for the division thereof shall run north and south, and the corners and contents of half quarter sections which may thereafter be sold, shall be ascertained in the manner, and on the principles directed and prescribed by the second section of an act ... passed on the eleventh day of February, eighteen hundred and five.*

An Act of April 5, 1832 provided for sales in areas as small as the quarter-quarter section and reiterated that the rules of the Act of February 11, 1805 apply to section subdivision.

> *And in every case of a division of a half-quarter section, the line for the division thereof shall run east and west, and the corners and contents of the quarter-quarter sections, which may thereafter be sold, shall be ascertained as nearly as may be, in the manner, and on the principles, directed and prescribed by the second section of an act, entitled "An act concerning the mode of surveying the public lands of the United States," passed on the eleventh day of February, eighteen hundred and five.*

An Act of September 27, 1850, created the office of Surveyor General of the Public Lands in Oregon and provided for the survey and the making of Donations to the settlers of those Public Lands. The act is called, among other names, the Donation Land Act. John B. Preston was appointed the first Surveyor General of Oregon. The survey's were to extend over the area of the current States of Oregon and Washington, and the Donations, because they required surveys of land claims that predated the surveys of the townships, were to result in thousands of special surveys that did not conform to the rectangular system, mostly in the Willamette Valley but also in the early settled areas of Washington such as Vancouver, Olympia and Port Townsend.

In 1856 the Surveyor General of Illinois and Missouri wrote section subdivision instructions that specified that the center of section should be established at the midpoint of the east-west centerline. In 1859 Abraham Lincoln wrote a section subdivision opinion disputing the Surveyor General's ideas. Lincoln's opinion has been supported subsequently by the GLO and the BLM.

> *The 11th Section of the Act of Congress, approved Feb. 11, 1805, prescribing rules for the subdivision of Sections of land within the United States system of Surveys, standing unrepealed, in my opinion, is binding on the respective purchasers of different parts of the same Section, and furnishes the true rule for Surveyors in establishing lines between them. That law, being in force at the time each became a purchaser, becomes a condition of the purchase.*
>
> *And, by that law, I think the true rule for dividing into quarters, any interior*

Section, or Section which is not fractional, is to run straight lines through the Section from the opposite quarter section corners, fixing the point where such straight lines cross, or intersect each other, as the middle, or center of the Section.

Nearly, perhaps quite, all the original surveys are to some extent, erroneous, and in some of the Sections, greatly so. In each of the latter, it is obvious that a more equitable mode of division than the above might be adopted; but as error is infinitely various, perhaps no better single rule can be prescribed.

At all events I think the above has been prescribed by the competent authority. Springfield, Jany. 11, 1859. A. Lincoln

On November 1, 1879 Acting Commissioner of the GLO, J. M. Armstrong, issued Circular 27 which addressed the subdivision of sections. The following is a portion of the circular.[3]

Under the provisions of the Act of Congress approved February 11, 1805, the course to be pursued in the subdivision of sections is to run straight lines from the established quarter-section corners--United States surveys--to the opposite corresponding corners, and the point of intersection of the lines so run will be the corner common to the several quarter-sections, or, in other words, the ***legal center of the section****.*

In the subdivision of fractional quarter-sections *where no opposite corresponding corners have been or can be fixed, the subdivision lines should be ascertained by running from the established comers due north, south, east, or west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional section.*

The law presupposes the section lines surveyed and marked in the field by the United States deputy surveyors to be due north and south or east and west lines, but in actual experience this is not always the case; hence, in order to carry out the spirit of the law, it will be necessary, in running the subdivisional lines through fractional sections, to ***adopt mean courses where the section lines are not due lines, or to run the subdivision line parallel to the section line when there is no opposite section line.***

Upon the lines closing on the north and west boundaries of a township, the quarter-section corners are established by the United States deputy surveyors at precisely forty chains to the north or west of the last interior section corners, and the excess or deficiency in the measurement is thrown on the outer tier of lots, as per Act of Congress approved May 10, 1800.

In the subdivision of quarter-sections *the quarter-quarter corners are to be placed at points equidistant between the section and quarter-section corners and between the quarter corners and the common center of the section, except on the last half mile of the lines closing on the north or west boundaries of a township, where they should be placed at twenty chains, proportionate measurement, to the north or west of the quarter-section corner.*

The subdivision lines of fractional quarter-sections *should be run from points on the section lines intermediate between the section and quarter-section corners due north,*

3 A History of the Rectangular Survey System by C. Albert White, pages 509 and 510.

south, east, or west, to the lake, water-course, or reservation which renders such tracts fractional.

***When there are double sets of section corners** on township and range lines, the quarter corners for the sections south of the township lines and east of the range lines are not established in the field by the United Stated surveyors, but in subdividing such sections said quarter corners should be so placed as to suit the calculations of the areas of the quarter-sections adjoining the township boundaries as expressed upon the official plat, adopting proportionate measurements where the present measurements of the north or west boundaries of the sections differ from the original measurements.*

In 1887 Commissioner Sparks issued Circular 119 which expanded slightly upon the section subdivision instructions in Circular 27. These and subsequent instructions are essentially the same as found in the 1973 BLM Manual of Surveying Instructions.

The Act of July 9, 1870, codified in Title 43, Chapter 18, Paragraph 766 of United States Code, for the first time officially allowed *county and local surveyors* to subdivide surveyed public land. In practice, they had been subdividing sections since much earlier.

"and all subdividing of surveyed lands into lots less than one hundred and sixty acres may be done by county and local surveyors at the expense of claimants"

The above laws were incorporated into the United States Code as follows. They are the basis for much in the material in GLO and BLM Manuals and Circulars.

UNITED STATES CODE
TITLE 43 - PUBLIC LANDS
CHAPTER 18 - SURVEY OF PUBLIC LANDS

§ 752 Boundaries and contents of public lands; how ascertained

First. All the corners marked in the surveys, returned by the Secretary of the Interior or such agency as he may designate, shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate; and the corners of half- and quarter-sections, not marked on the surveys, shall be placed as nearly as possible equidistant from two corners which stand on the same line.

Second. The boundary lines, actually run and marked in the surveys returned by the Secretary of the Interior or such agency as he may designate, shall be established as the proper boundary lines of the sections, or subdivisions, for which they were intended, and the length of such lines as returned, shall be held and considered as the true length thereof. And the boundary lines which have not been actually run and marked shall be ascertained, by running straight lines from the established corners to the opposite corresponding corners; but in those portions of the fractional townships where no such opposite corresponding corners have been or can be fixed, the boundary lines shall be ascertained by running from the established corners due north and south or east and west lines, as the case may be, to the watercourse, Indian boundary line, or other external boundary of such fractional township.

Third. Each section or subdivision of section, the contents whereof have been returned by the Secretary of the Interior or such agency as he may designate, shall be

held and considered as containing the exact quantity expressed in such return; and the half sections and quarter sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one-half or the one-fourth part, respectively, of the returned contents of the section of which they may make part.

Derived from Act Feb. 11, 1805

§ 753. Lines of division of half quarter sections; how run

In every case of the division of a quarter section the line for the division thereof shall run north and south, and the corners and contents of half quarter sections which may thereafter be sold, shall be ascertained in the manner and on the principles directed and prescribed by section 752 of this title, and fractional sections containing one hundred and sixty acres or upwards shall in like manner as nearly as practicable be subdivided into half quarter sections under such rules and regulations as may be prescribed by the Secretary of the Interior, and in every case of a division of a half quarter section, the line for the division thereof shall run east and west, and the corners and contents of quarter quarter sections, which may thereafter be sold, shall be ascertained as nearly as may be, in the manner, and on the principles, directed and prescribed by the section preceding; and fractional sections containing fewer or more than one hundred and sixty acres shall in like manner, as nearly as may be practicable, be subdivided into quarter quarter sections, under such rules and regulations as may be prescribed by the Secretary of the Interior.

Derived from Acts Apr. 24, 1820 and Apr. 5, 1832

The first GLO Restoration Circular, published in 1883 summarized Congressional legislation in five points. The wording has changed some in subsequent circulars, but the same five points appear in the most recent Restoration Circular in 1974.

The general rules followed by the Bureau of Land Management, which are controlling upon the location of all public lands, are summarized in the following paragraphs:

First: That the boundaries of the public lands, when approved and accepted, are unchangeable.

Second: That the original township, section, and quarter-section corners must stand as the true corners which they were intended to represent whether in the place shown by the field notes or not.

Third: That quarter-quarter-section corners not established in the original survey shall he placed on the line connecting the section and quarter-section corners, and midway between them, except on the last half mile of section lines closing on the north and west boundaries of the township, or on the lines between fractional or irregular sections.

Fourth: That the center lines of a section are to be straight, running from the quarter section corner on one boundary to the corresponding corner on the opposite boundary.

Fifth: That in a fractional section where no opposite corresponding quarter section corner has been or can be established, the center line must he run from the proper quarter-section corner as nearly in a cardinal direction to the meander line,

reservation, or other boundary of such fractional section, as due parallelism with the section boundaries will permit.

From the foregoing it will he evident that corners established in the public land surveys remain fixed in position and are unchangeable; and that lost or obliterated corners of those surveys must be restored to their original locations from the best available evidence of the official survey in which such corners were established.

It is sometimes said that once public land is patented and passes out of federal control, the subdivision of that land is subject to State law. The State of Washington Administrative Code has established that the GLO and BLM methods are the legally prescribed methods for the State and additionally requires that surveys show the method of subdivision, the controlling corners, and the calculations. This requirement is too often ignored.

WAC 332-130-030 Land subdivision and corner restoration standards--Recording.

(1) The reestablishment of lost GLO or BLM corners and the subdividing of sections shall be done according to applicable GLO or BLM plats and field notes and in compliance with the rules as set forth in the appropriated GLO or BLM Manual of Surveying Instructions, manual supplements and circulars. Federal or state court decisions that influence the interpretation of the rules should be considered. Methods used for such corner reestablishment or section subdivision shall be described on the survey map produced.

(2) All maps, plats, or plans showing a land boundary survey shall show all the corners found, established, reestablished and calculated, including corresponding directions and distances, which were used to survey and which will be necessary to resurvey the parcel shown. Additionally, all such maps, plats, or plans shall show sufficient section subdivision data, or other such controlling parcel data, necessary to support the position of any section subdivisional corner or controlling parcel corner used to reference the parcel surveyed. Where a portion or all of this information is already shown on a record filed or recorded in the county recording office of the county in which the parcel is located, reference may be made to that record in lieu of providing the required data.

II. Restoration of Lost Corners

1. Principles for the Restoration of Lost Federal Survey Corners

The Act of February 11, 1805 and Title 43, Chapter 18 of the United States Public Code, provides that the corners of federal surveys are not subject to change. The corners are located wherever the federal surveyor put the monument, so long as the survey was approved. They cannot be moved to a location more in harmony with the intent of the federal survey or to where the plat of the federal survey shows the corner to be by distance and direction from other corners.

If the original corner position is lost, then the surveyor must ensure that the corner is located where it will be accepted by the courts, which, in the State of Washington, means using the methods provided by BLM instructions. Because the courts will hold to the original corner position, the surveyor must be certain that the corner is actually lost before resorting to the techniques for the restoration of lost corners. In addition to following BLM procedures the surveyor may be required to adhere to relevant state laws and court decisions.

An important thread in all the BLM rules for restoring lost corners is the attempt to put the corner as close as possible to its original position as defined by the plat and field notes. The surveyor does not try to put the corner monument where it ought to have been placed. He tries to put it where it was actually established. Although the last resort, reliance on distances to other federal corners, i.e. proportioning, will not result in a restoration of a corner to its original location, it will result in a fair distribution of the land areas based on the survey record.

2. The Basis of Bearings for Public Land Surveys

Lost federal corners often cannot be restored without being able to duplicate the basis of bearings of the original survey. If direction is important to the restoration, the restoration cannot take place without reference to the basis of bearings, which is true mean astronomic.

The Land Ordinance of 1785
AN ORDINANCE FOR ASCERTAINING THE MODE OF DISPOSING OF LANDS IN THE WESTERN TERRITORY
Passed May 20, 1785

The surveyors, as they are respectively qualified, shall proceed to divide the said territory into townships of 6 miles square, by lines running due north and south, and others crossing these at right angles, as near as may be.

From the 1973 BLM Manual of Surveying Instructions:

THE DIRECTION OF LINES

2-17. The direction of each line of the public land surveys is determined with reference to the true meridian as defined by the axis of the earth's rotation. Bearings are stated in terms of angular measure referred to the true north or south.

In Public Land Surveys lines which have the same bearing are not parallel and parallel lines have different bearings. In Figure 1 below, the meridional lines are straight but not parallel and the east-west lines at a constant angle to the meridional lines, i.e. of constant and same bearing, are curved lines. The straight east-west lines have a constantly changing angle or bearing with respect to the meridional lines. The true mean astronomic bearing of a straight line is the astronomic bearing at the midpoint of the line.

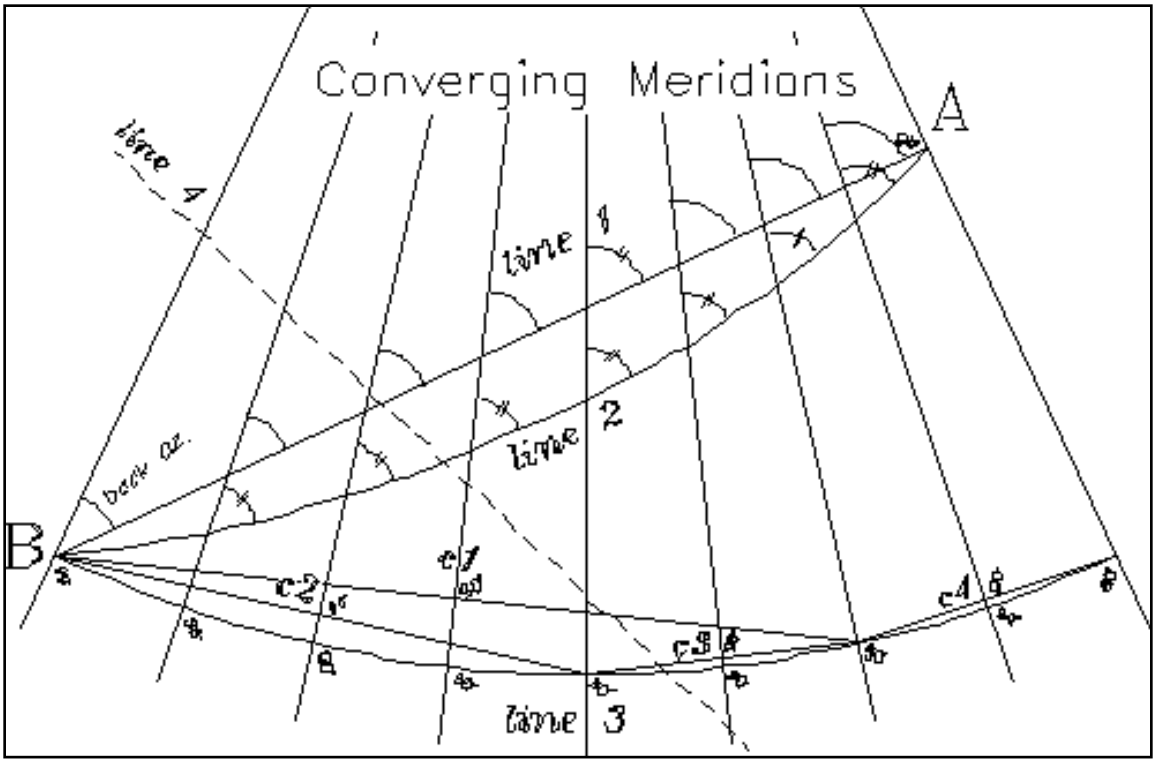


Figure 1

The sequence of lines as they were meant to be surveyed in a township subdivision is shown in Figure 2 below. The sequence was not always followed in the field but was reflected in the official field notes. Understanding the sequence helps one to follow the field notes.

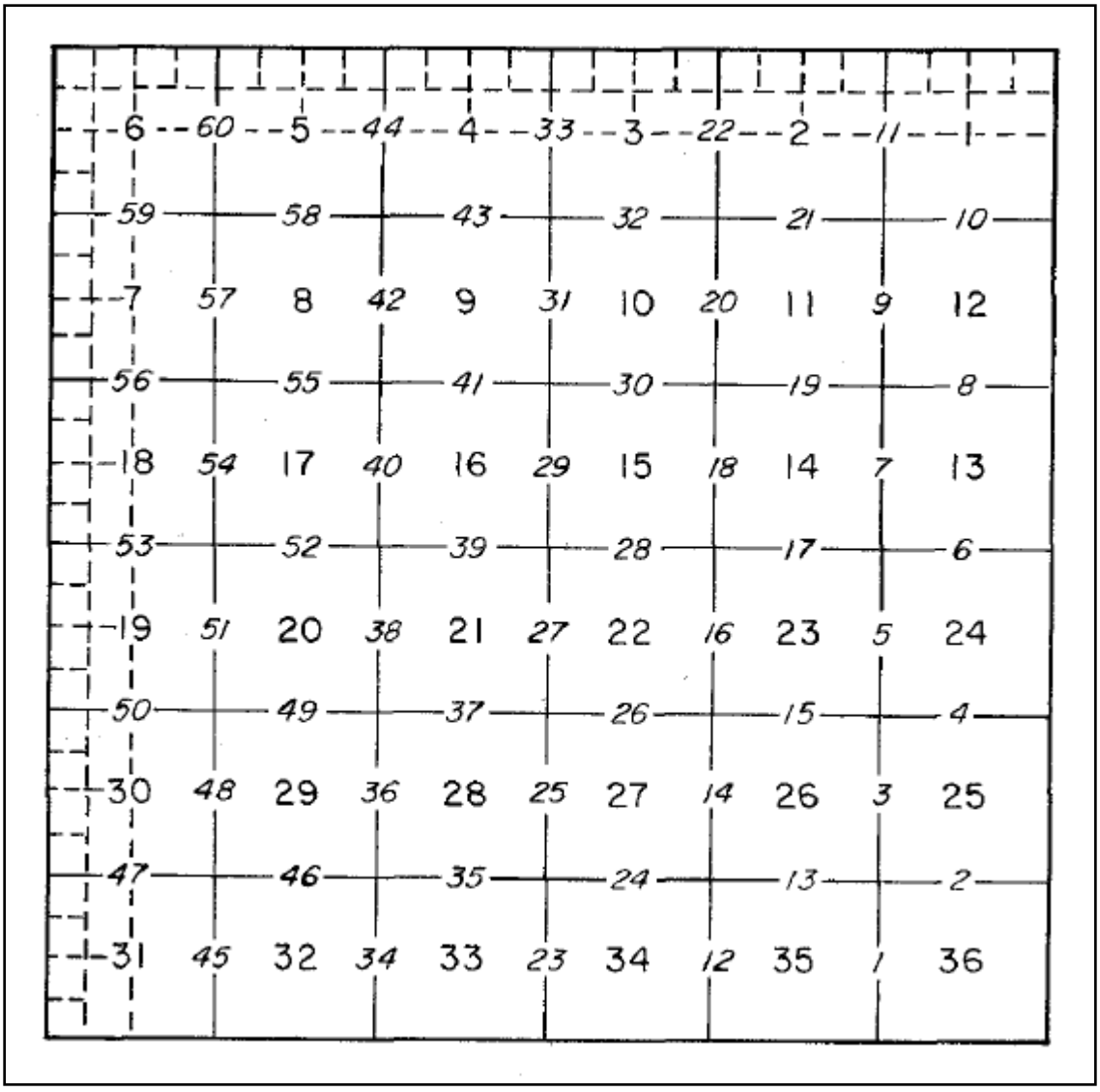


Figure 2

3. Summary of Proportioning Applications

When to Single Proportion (Manual 5-30)

- all standard corners
- all corners on township and range lines, except township corners
- corners on base lines, standard parallels, and correction lines
- 1/4 corners interior to a township
- meander corners
- closing corners

When to Double Proportion (Manual 5-25)

- township corner common to four townships
- section corners interior to a township

When to use Single Point Control (Manual 5-28,5-45)

- any corner set from only one direction

When to use Two Point Control (Manual 5-29)

- township or section corner on two surveyed lines only

When to use Three Point Control (Extends the logic of Manual 5-29)

- township or section corner on three surveyed lines only

When to use the Grant Boundary Method (Manual 5-44)

- donation land claims ?
- homestead entry surveys
- mineral surveys?
- tract corners
- townsites
- military/indian/etc. reservations
- state/international lines (careful!)

When to use Irregular Boundary Methods (Manual 5-36,5-43)

- mineral surveys (There are no set rules for the restoration of a lost mineral survey corner.)
- 1/4 corner on broken boundary of record
- non-riparian meander lines

Single proportion all standard corners and all corners on township and range lines, except township corners.

In Figure 3 below all the standard corners for the township to the north and all the corners on the township exterior, except the southwest and southeast township corners, would be single proportioned.

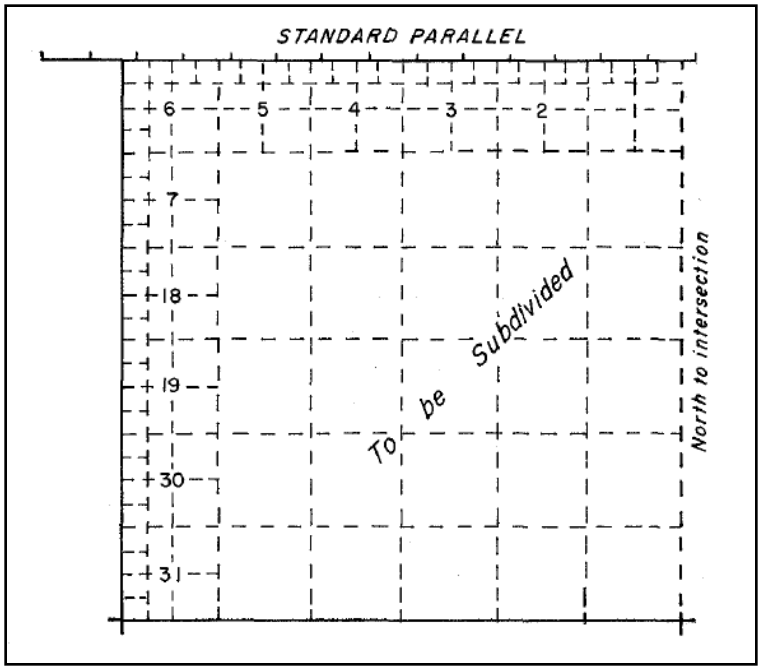


Figure 3

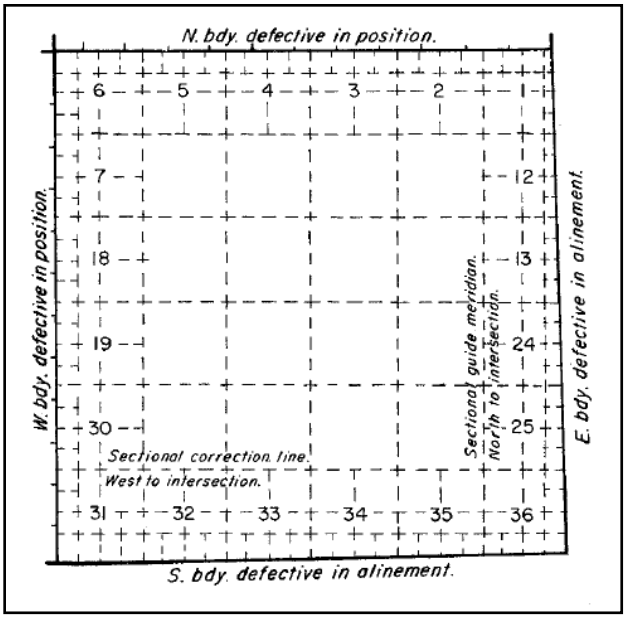


Figure 4

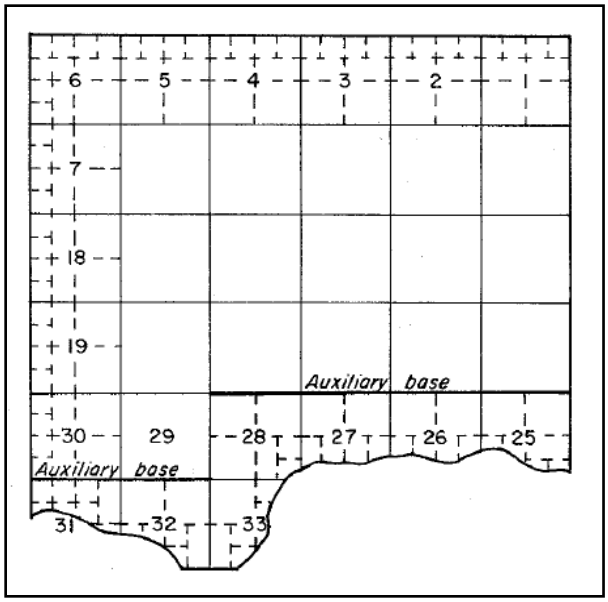


Figure 5

Single proportion corners on base lines, standard parallels, and correction lines.

See Figure 3 on page 20 for a standard parallel. Figure 4 on page 20 shows a sectional correction line, established because the south township boundary was defective in alignment, and a sectional guide meridian, established because the east township boundary was defective in alignment. Figure 5 on page 20 shows two auxiliary base lines, established because the south township boundary was missing due to the encroachment of a body of water.

Single proportion 1/4 corners interior to a township.

Figure 2 on page 18 shows the normal order of township subdivision and the numbers of the lines show the positions of quarter corners which would be single proportioned.

Single proportion meander corners (non-terminal).

The section in Figure 6 below has meander corners along its west and south boundaries. The river was measured across, making the meander corners "non-terminal" and missing meander corners would be established by single proportion.

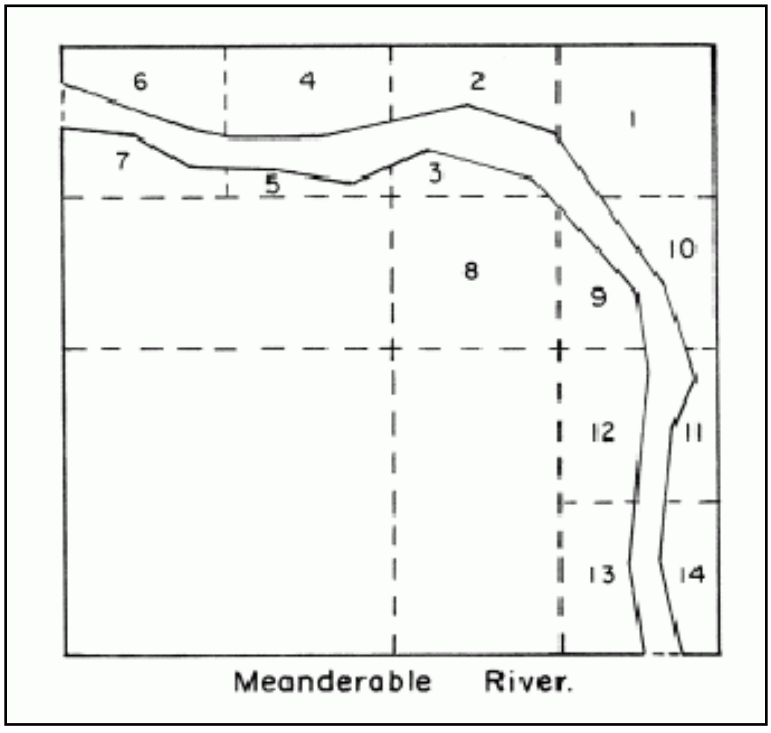


Figure 6

Single proportion closing corners.

The closing corners in Figure 7 below on the north lines of sections 3 and 4 would be single proportioned between the standard corners on the township line.

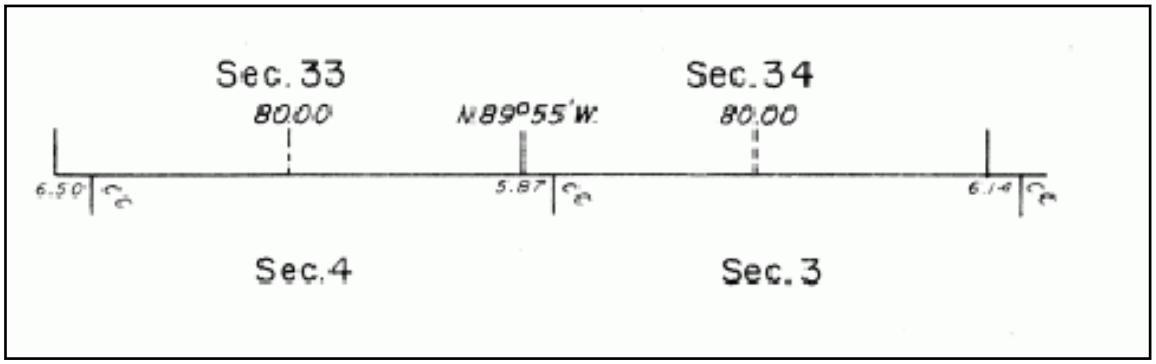


Figure 7

The closing corners on the Indian reservation boundary in Figure 8 below would be single proportioned between the nearest reservation boundary corners.

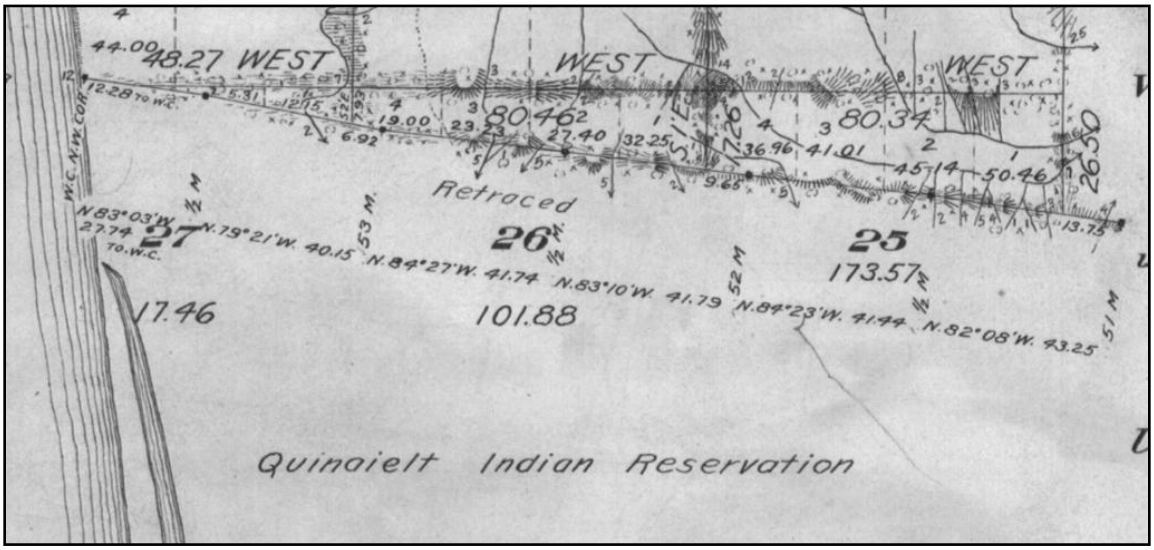


Figure 8

Double proportion township corners common to four townships.

The township corners, except those on the base line and standard parallels, would be double proportioned between the nearest corners north, south, east and west.

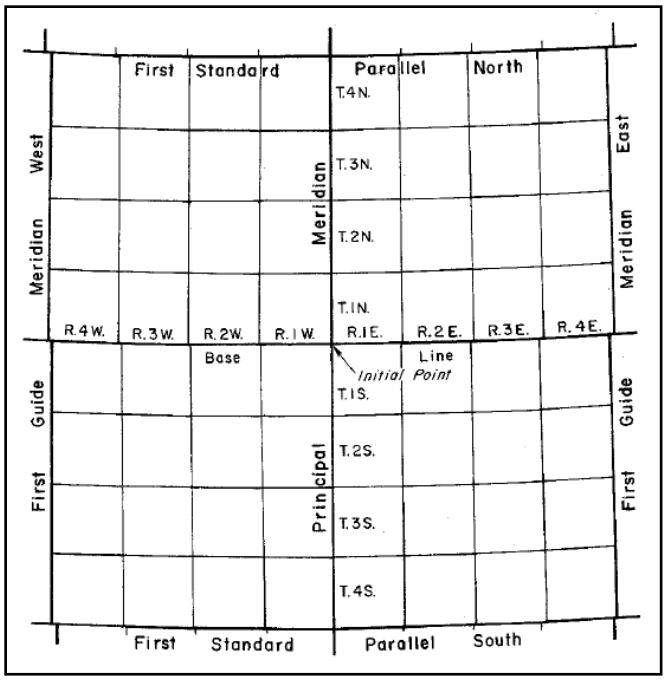


Figure 9

Double proportion section corners interior to a township.

The interior section corners would be double proportioned between the nearest corners north, south, east and west.

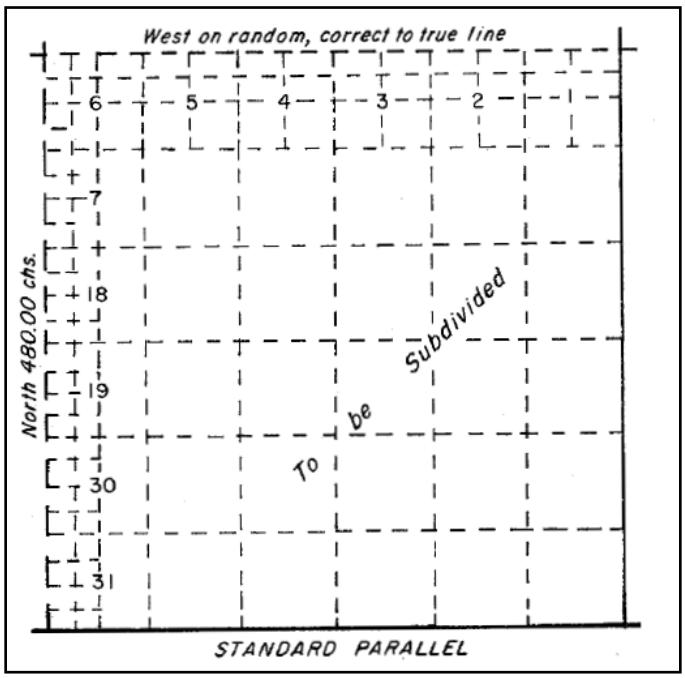


Figure 10

Use single point control for any corner set from only one direction.

The terminal meander corners in Figure 11 below would be restored by one point control.

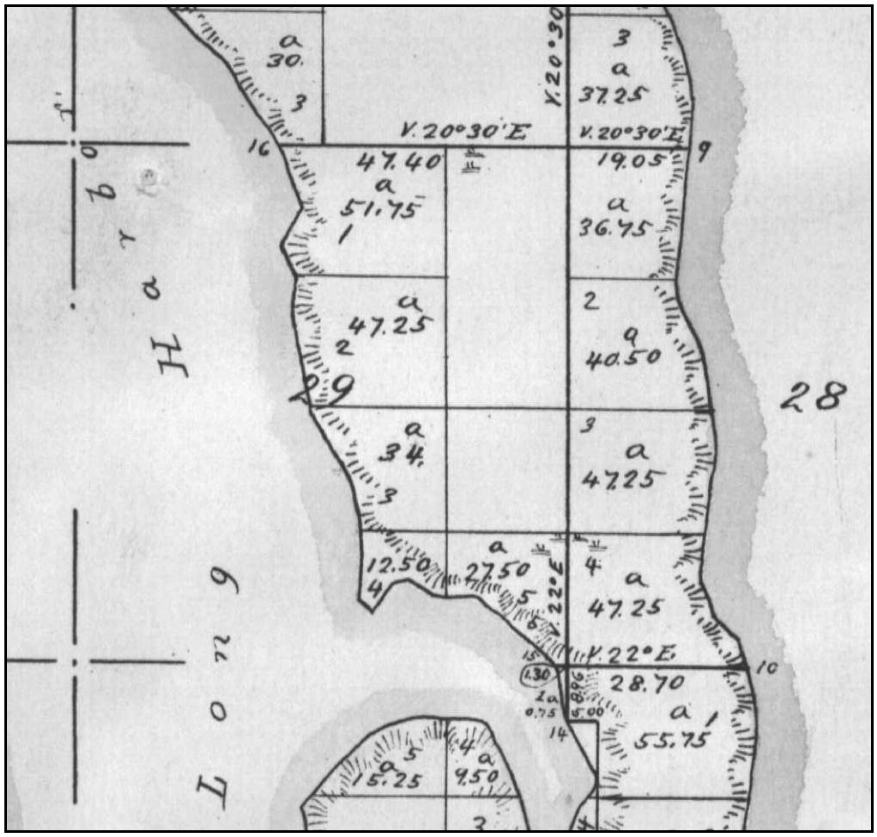


Figure 11

The quarter corner between sections 8 and 9, in Figure 12 below, is at the end of a surveyed line and would be restored by single point control.

Use Two Point Control when a township or section corner is on two surveyed lines only.

The southeast corner of section 16 in Figure 12 below is on two surveyed lines only and would be restored by two point control.

Use Three Point Control when a township or section corner is on three surveyed lines only.

The southwest corner of section 16 in Figure 12 below is on three surveyed lines only and would be restored by three point control.

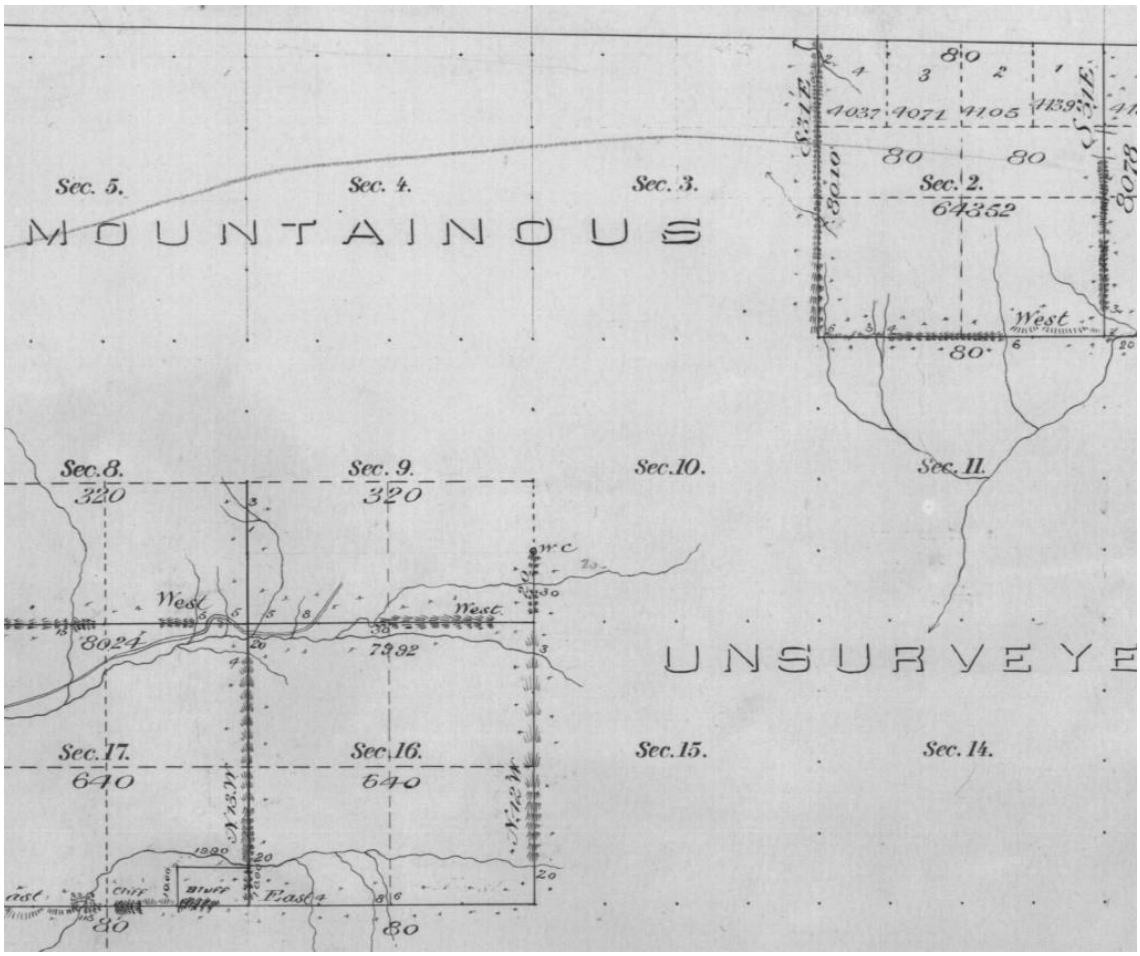


Figure 12

You might use the grant boundary method for Donation Land Claim corners. See Manual section 5-44.

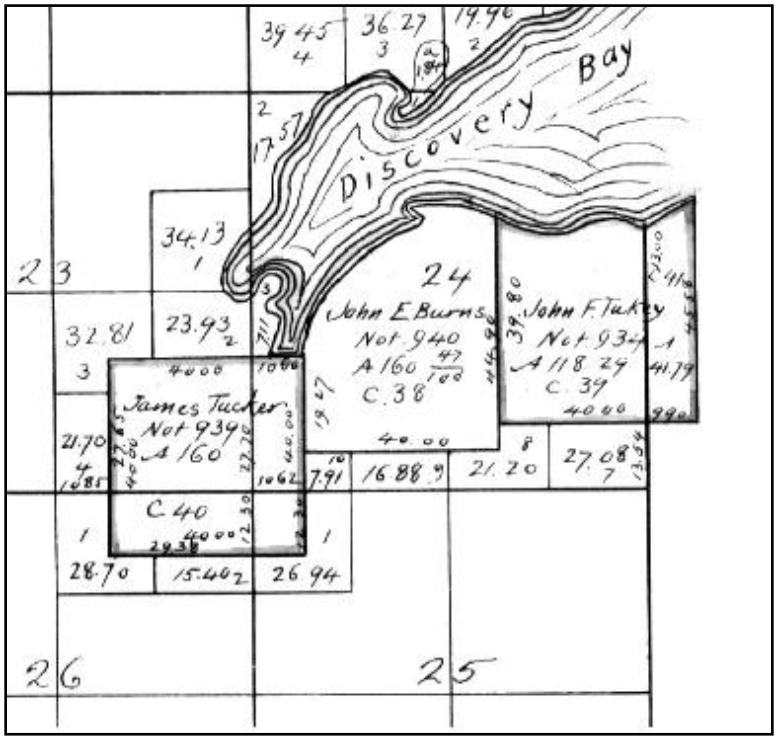


Figure 13

Use irregular boundary method, a modified form of single proportionment, for a 1/4 corner on a broken boundary of record. See Manual section 5-36.

The west quarter corner of section 35 would have to be reestablished by the modified form of single proportionment.

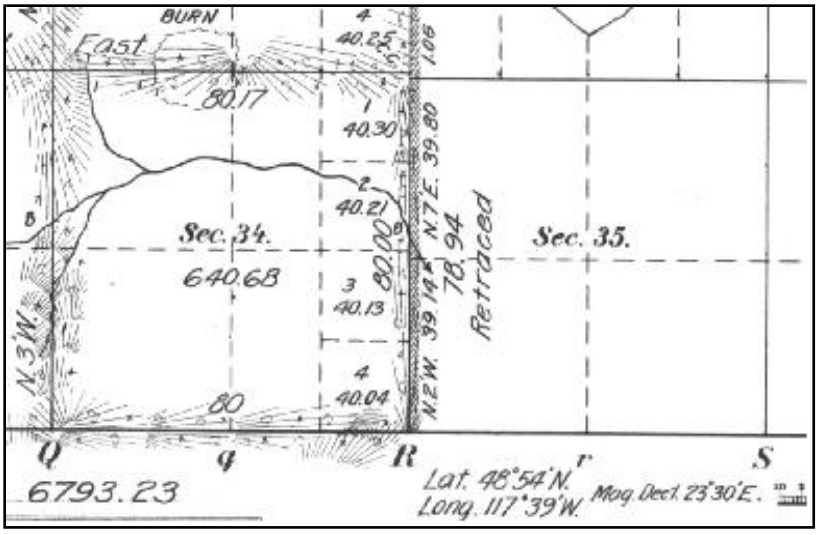


Figure 14

Use irregular boundary method, a compass rule adjustment, for a non-riparian meander line. See Manual section 5-43.

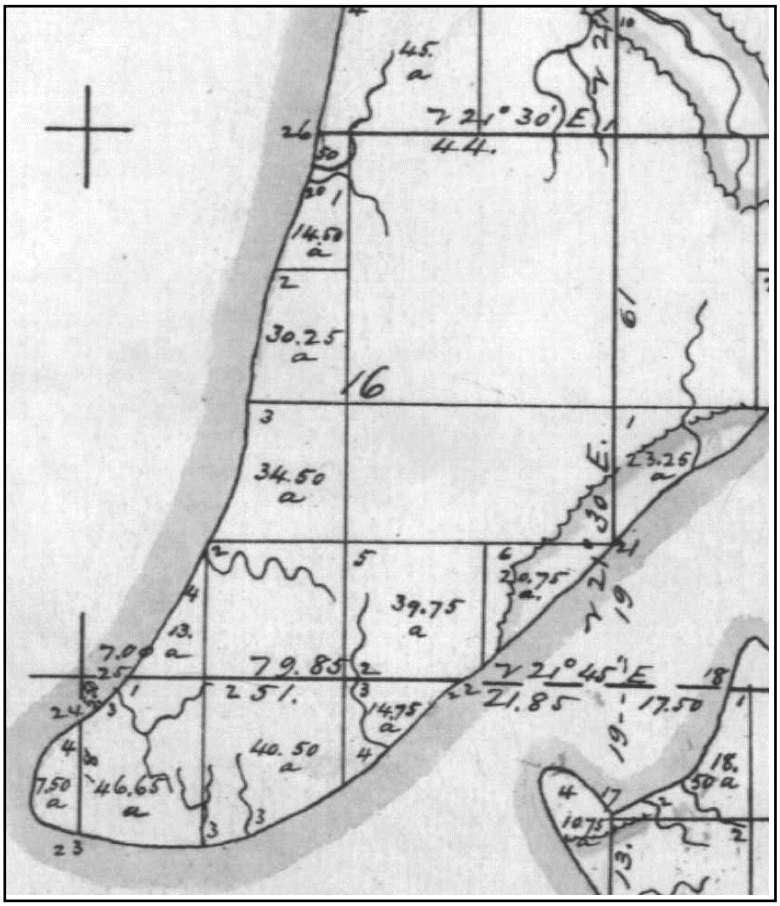


Figure 15

4. Proportionate Measurement Overview

Proportionate measurement is a distribution of the differences between an original measurement and a new measurement. Proportionate measurement should distribute the differences equally to every part of the line. Don't use proportioning blindly as a standard method for dealing with GLO corners. On the other hand, if you do use proportioning methods, use them correctly.

Proportionate measurement is a good way to distribute systematic and random errors which result from two different measurements of a line or lines. Systematic errors result from some part of the system being a out of calibration. An example would be the original surveyor's chain being a little to long or to short. Random errors happen unpredictably and because we are not perfect. An example would be the original surveyor imperfectly placing the chaining pin exactly at the distance measured. A blunder is distinguished from a random error by being a mistake. An example of a blunder would be the original surveyor miscounting the number of chains (or

half-chains) in the measurement of a section line. This is very different from the random error created by not perfectly placing the chaining pin in the ground.

Proportionate measurement is not intended to distribute errors caused by blunders.

Manual 5-23. All discrepancies in measurement should be carefully verified with the object of placing each difference where it properly belongs. Whenever it is possible to do so, the manifest errors in measurement are removed from the general average difference and placed where the blunder was made.

An Example of a Blunder - From a GLO plat
surveyed by GLO contract surveyor Gile.

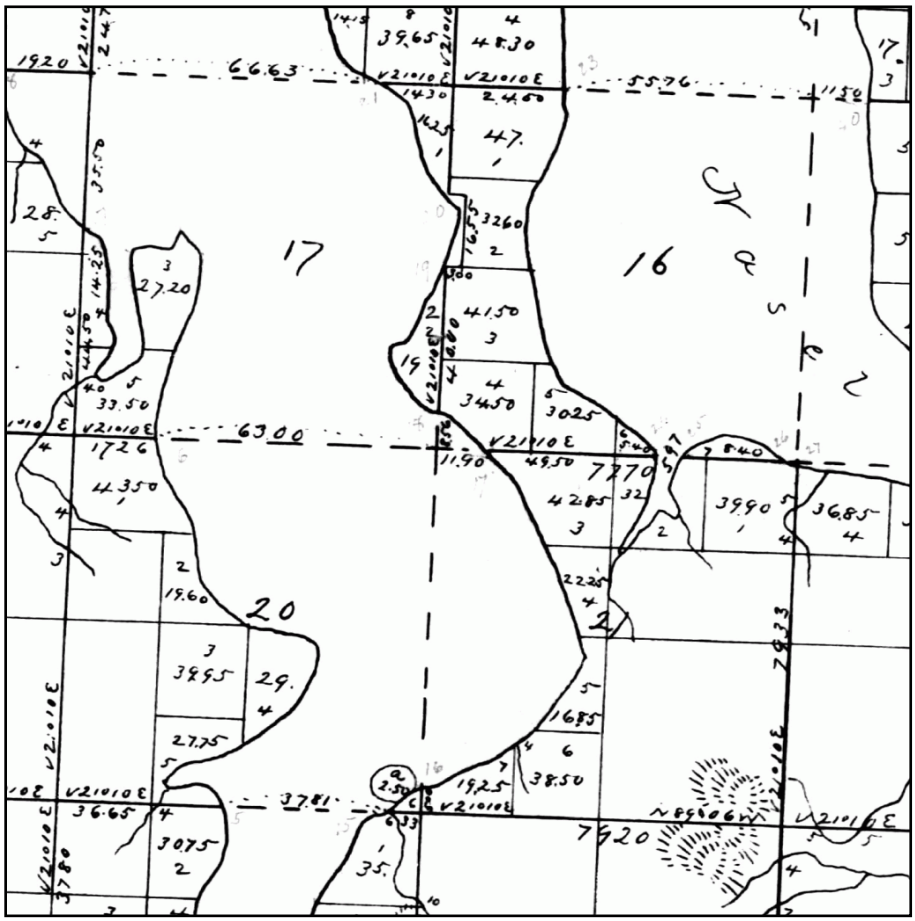


Figure 16

The following is from a letter issued by the Oregon State Office of the BLM explaining the method they would use to re-establish the lost section corner common to sections 16, 17, 20 and 21 in Figure 16 above.

It appears Gile's measurements by triangulation have a significant amount or error. However, your measurements between found original corners indicate his chaining was good. He actually chained out to several of the corners which fell on the tidelands including the point for the corner of sections 16, 17, 20, and 21 where he set a flag to use for his triangulation to the south and west. Using double proportion to reestablish the corner point will put a considerable amount of distortion in the lines going north and east, distortion that undoubtedly was not in the original survey. Therefore, we feel the best method of reestablishing the point for the corner of sections 16, 17, 20, and 21 is by two point control at record departure from the found meander corner between sections 16 and 21, and at record latitude from the found meander corner between sections 16 and 17. This would leave some distortion, but we feel this method best protects the original survey.

i. Single Proportionate Measurement

From the 1973 BLM Manual of Surveying Instructions:

5-30. The term "single proportionate measurement" is applied to a new measurement made on a line to determine one or more positions on that line.

By single proportionate measurement the position of two identified corners controls the direction of that line. The method is sometimes referred to as a "two-way" proportion, such as a north-and-south proportion or an east-and-west proportion. Examples are a quarter-section corner on the line between two section corners, all corners on standard parallels, and all corners occupying intermediate positions on a township boundary line.

5-31. In order to restore a lost corner on a line by single proportionate measurement, a retracement is made connecting the nearest identified corners on the line. These corners control the position of the lost corner. Control corners are usually corners established in the original survey of the line. The lost corner is then reestablished at proportionate distance on the true line connecting the recovered corners. Proper adjustment is made on an east and west line to secure the latitudinal curve. Any number of intermediate lost corners may be located on the same plan.

The south quarter corner of Section 16, T30N, R44E, (see Figure 29 on page 45) is an example of single proportioning. In that example the GLO quarter corner was placed at 40.17 chains, a midpoint of the entire distance of 80.34 chains. The single proportioned quarter corner is put at a midpoint on the line to preserve the proportions of the GLO survey and plat.

Many single proportion positions are not midpoints. Examples are closing corners along a township line and quarter corners connecting to the north and west township lines.

Single Proportion Example, Section 4, T34N, R38E, W.M., Stevens County, Washington

This survey, Figure 17, has examples of single proportioning a closing corner, a quarter corner, and a 1/16th corner. The 1/16th corner, see Figure 21 on page 33, is not an example of a restoration of a lost corner but the proportioning calculation is the same as the calculation for a lost corner.

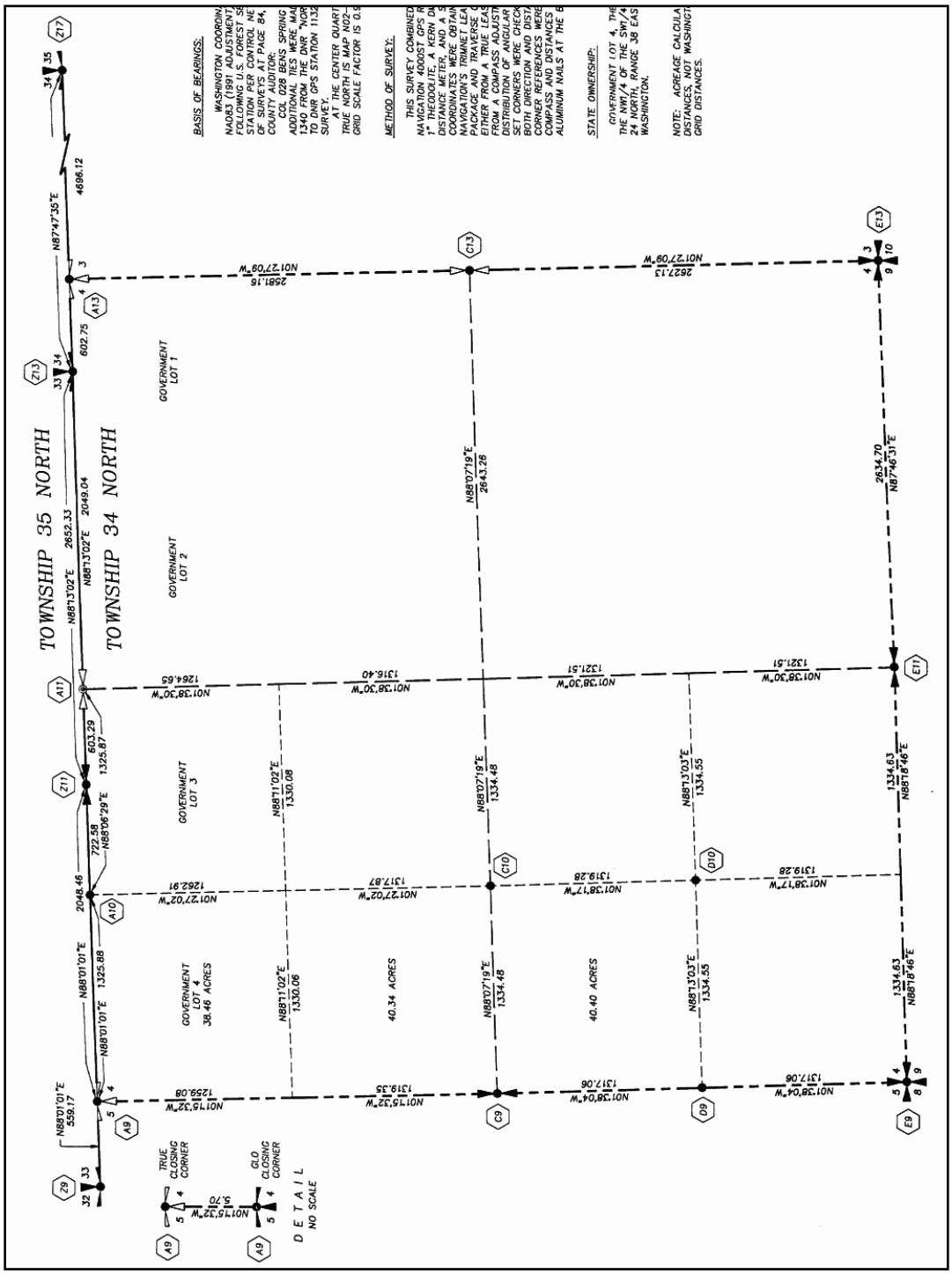


Figure 17

Plat of the 1896 GLO survey by Lewis D. W. Shelton

The GLO plat, Figure 18 below, shows the record measurements that are used for proportioning. In the case of the east and west quarter corners of section 4, the distances from the southeast and southwest section corners to the quarter corners are 40 chains, and the distances north of the quarter corners are the remainders. The plat ordinarily does not show distances for north-south lines where those distances are either 40 or 80 chains.

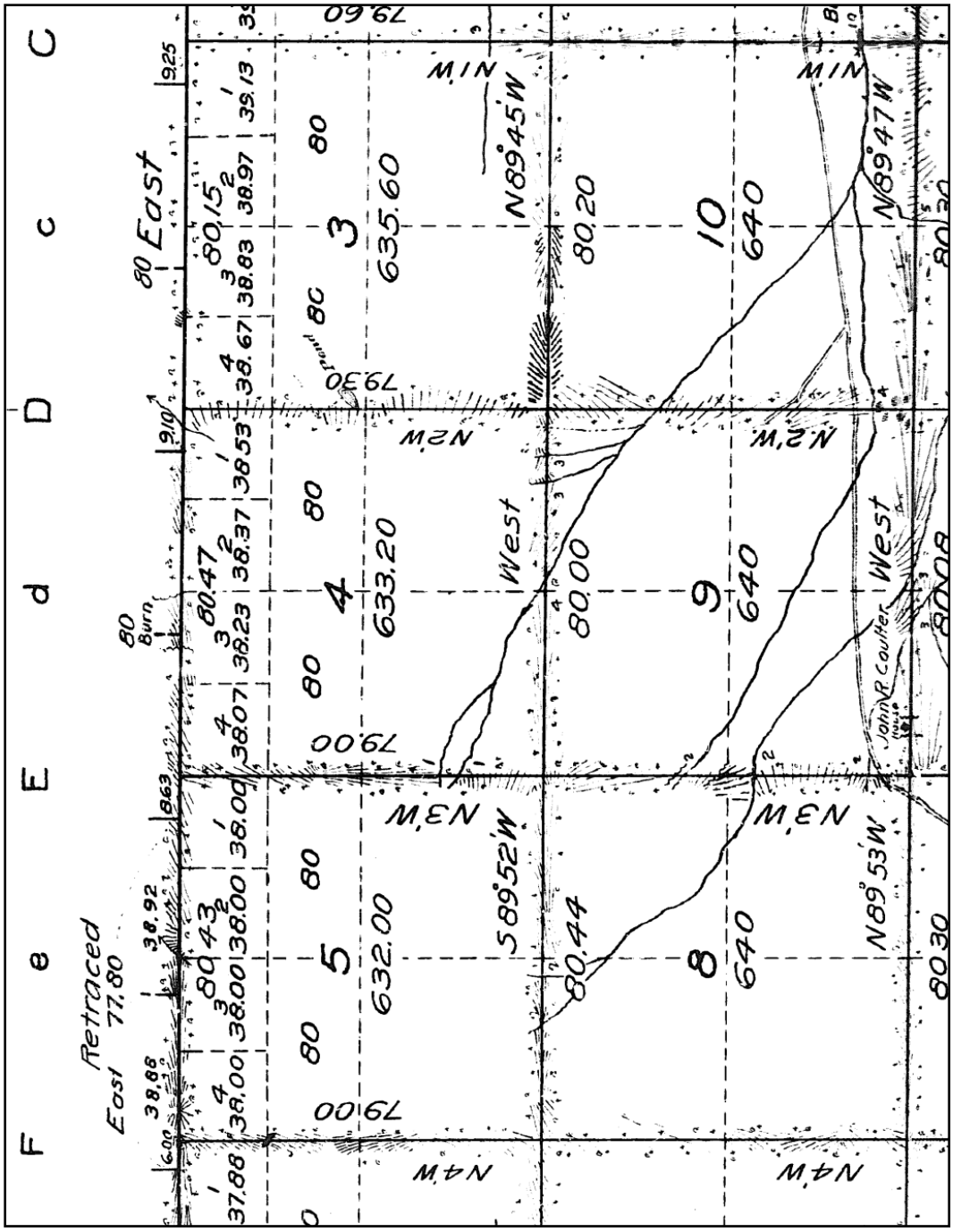


Figure 18

Single Proportion corner A13, the Closing Corner of Sections 4 and 3

See Figure 18 on page 31 for the GLO measurements and Figure 19 below for the restoration. The total GLO distance along the south boundary of Section 34 is 80 chains. The DNR survey measurement is 5298.87 feet. The proportion of feet to chains is 5298.87 / 80 = 66.2358750 feet per chain. The proportion allows us to convert the record measurements to measurements in the restoration survey.

The GLO set the closing corner 9.10 chains east of the southwest corner of section 34. Therefore the single proportioned position is (9.10 / 80) x 5298.87 = 602.75.

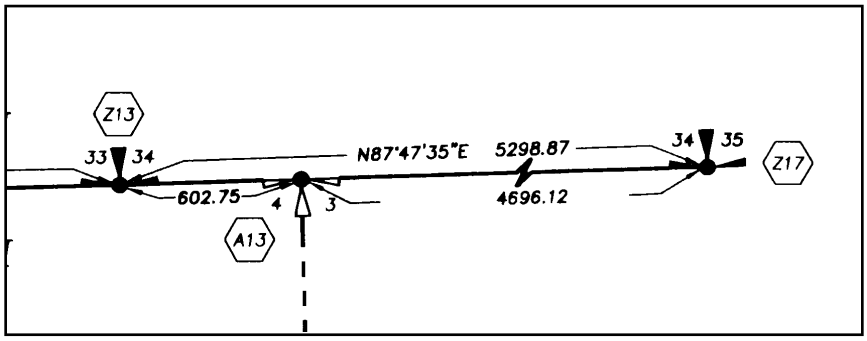


Figure 19

Single Proportion corner C13, the Quarter corner of Sections 4 and 3.

See Figure 18 on page 31 for the GLO measurements and Figure 20 below for the restoration. The total GLO distance along the section line is 79.30 chains, with 40 chains south of the 1/4 corner and 39.30 chains north of the 1/4 corner. The survey measurement is 5208.29 feet. The proportion of feet to chains is 5208.29 / 79.30 = 65.67831021 feet per chain.

The proportioned distance south of the 1/4 corner is (40 / 79.30) x 5208.29 = 2627.13.
The proportioned distance north of the 1/4 corner is (39.30 / 79.30) x 5208.29 = 2581.16.

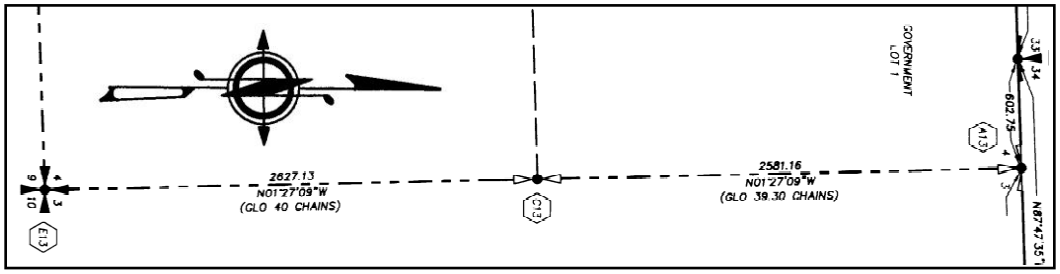


Figure 20

Calculate the Center North 1/16th corner between Sections 4 and 5

Note: When the original closing corner is found off the line closed upon, as with the closing corner of sections 5 and 4 in this survey, all proportioning is done to the original closing corner, not to the true closing corner.

The GLO distance from ¼ corner to closing corner is 39.00 chains.

The measured distance is 2572.73 feet.

Proportioned distance from ¼ corner to north 1/16 corner = (20.00 / 39.00) x 2572.73 = 1319.35 feet.

The proportioned distance from north 1/16 corner to the original closing corner = (19.00 / 39.00) x 2572.73 = 1253.38 feet.

The total distance from north 1/16 corner to the true closing corner on the township line = 1253.38 + 5.70 = 1259.08 feet.

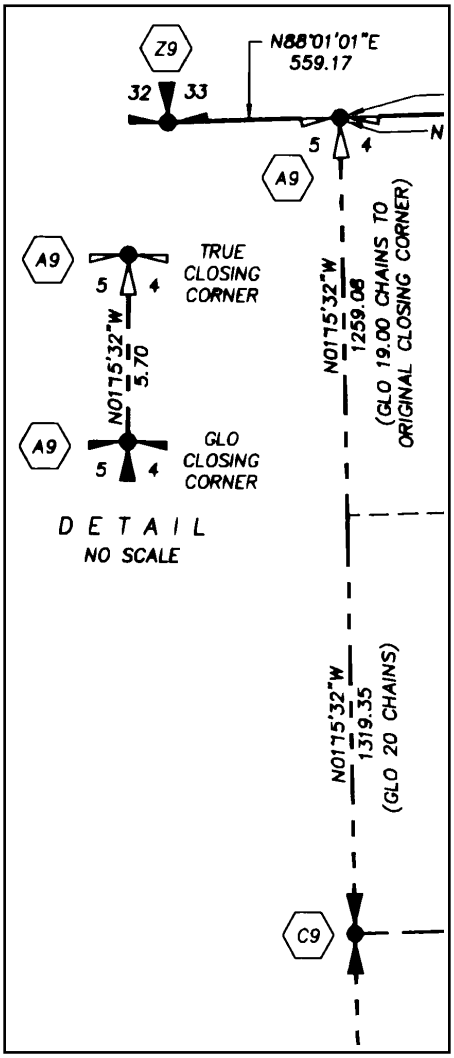


Figure 21

Single Proportion along a Sectional Correction Line

Township 35 North, Range 44 East, Pend Oreille County, Washington

The GLO plat, Figure 22 below, shows the north lines of sections 31, 32, and 33 to have a bearing of West. This is unusual because the east-west section lines are normally run between existing corners, except in the case of closing corners, and the bearings are normally cardinal. The notes for the survey, Figure 23 on page 35, make it clear that the three miles were run in a cardinal direction and the lines are a sectional correction line.

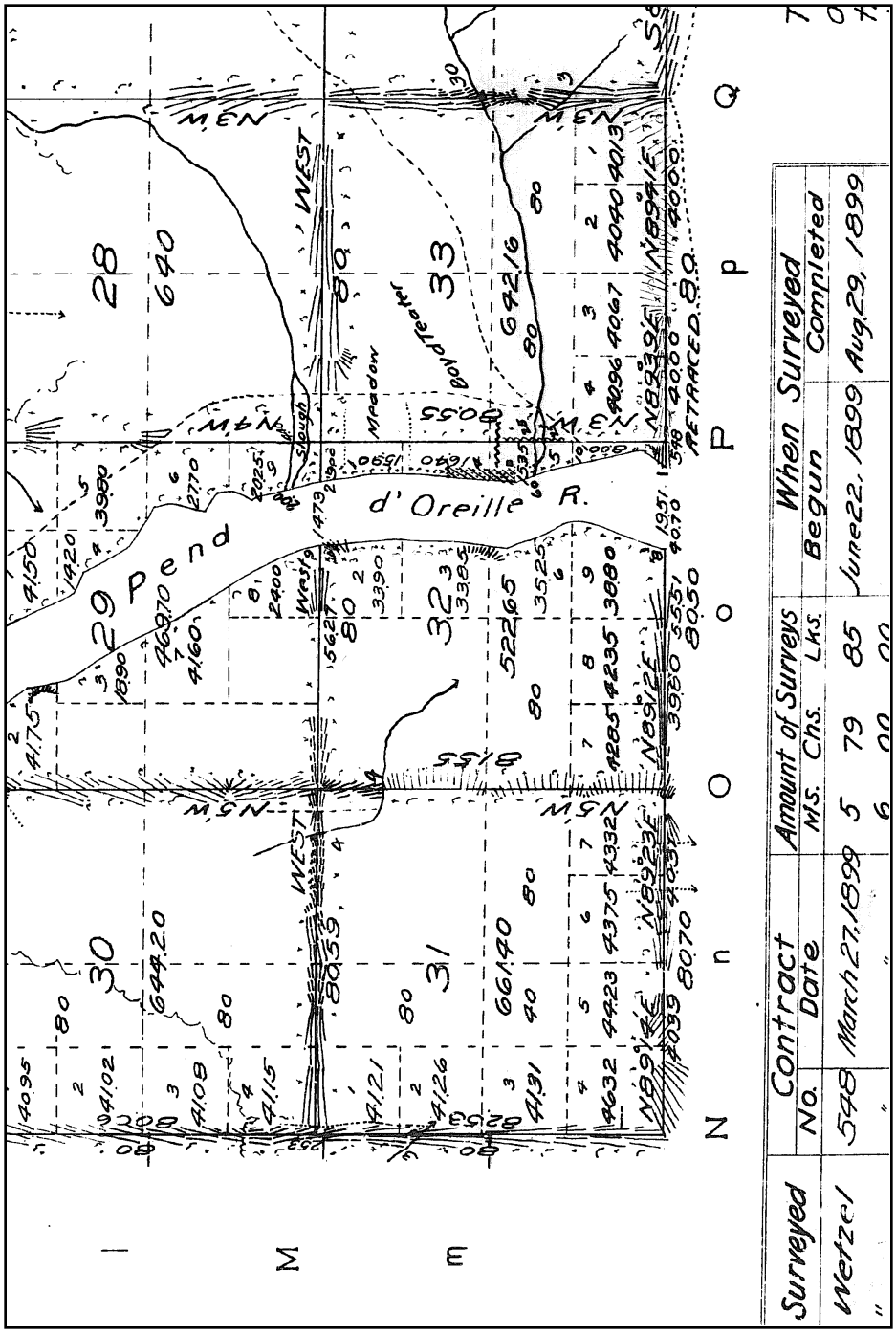
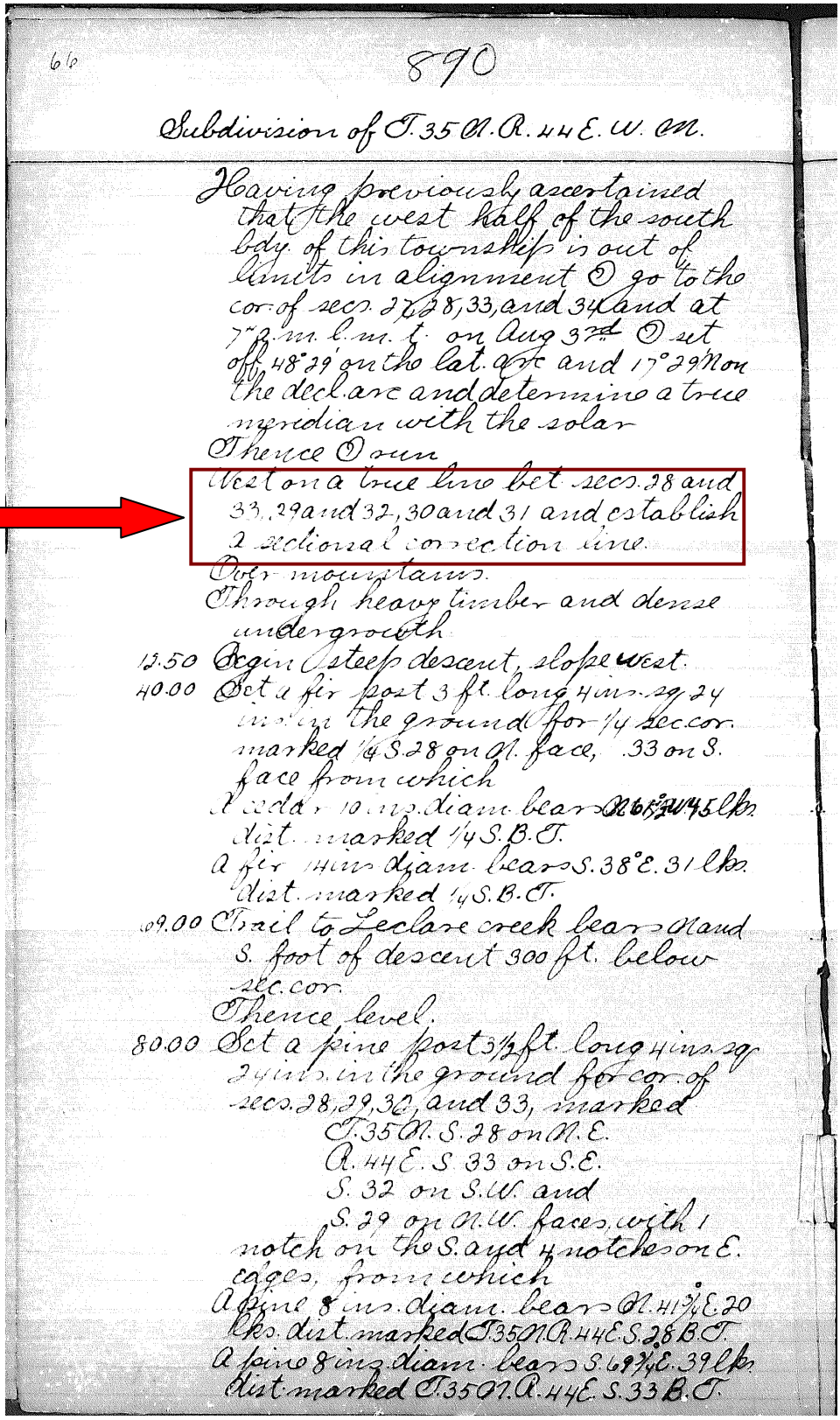


Figure 22



66

890

Subdivision of T. 35 N. R. 44 E. W. M.

Having previously ascertained that the west half of the south bdy. of this township is out of limits in alignment ① go to the cor. of secs. 27, 28, 33, and 34 and at 7 A.M. L.M. T. on Aug 3rd ① set off 48° 29' on the lat. of 45° and 17° 29' Mon the decl. arc and determine a true meridian with the solar

Thence ① run

West on a true line bet secs. 28 and 33, 29 and 32, 30 and 31 and establish 2 sectional cor. on section line.

Over mountains.

Through heavy timber and dense undergrowth.

12.50 Begin steep descent, slope West.

40.00 Set a fir post 3 ft. long 4 ins. sq. 24 ins. in the ground for 1/4 sec. cor. marked 1/4 S. 28 on N. face, 33 on S. face from which

A cedar 10 ins. diam. bear [illegible] 45 lks. dist. marked 1/4 S. B. T.

A fir 14 ins. diam. bears S. 38° E. 31 lks. dist. marked 1/4 S. B. T.

69.00 Trail to Leclare creek bears N and S. foot of descent 300 ft. below sec. cor.

Thence level.

80.00 Set a pine post 3½ ft. long 4 ins. sq. 24 ins. in the ground for cor. of secs. 28, 29, 32, and 33, marked

T. 35 N. S. 28 on N. E.
R. 44 E. S. 33 on S. E.
S. 32 on S. W. and
S. 29 on N. W. faces, with 1 notch on the S. and 4 notches on E. edges, from which

A pine 8 ins. diam. bears N. 41½ E. 20 lks. dist. marked T. 35 N. R. 44 E. S. 28 B. T.

A pine 8 ins. diam. bears S. 69¾ E. 39 lks. dist. marked T. 35 N. R. 44 E. S. 33 B. T.

Figure 23

Offset to the Latitudinal Curve

Single proportioned positions along a township line should be offset from a straight line to the latitudinal curve on which the original survey was made. The offsets are in a cardinal direction.

Using the method set out in POB Tech tips by Elgin, Knowles & Senne

Offset = (0.6668) (LW) (LE) (Tan Latitude)

Where:
- Offset is in feet from the single proportioned point on a straight line, e.g. chord or secant of the latitudinal curve.
- 0.6668 is a constant derived to make this equation simpler than it might be.
- LW is the distance west, <u>in miles</u>, from the single proportioned point to the known point.
- LE is the distance east, <u>in miles</u>, from the single proportioned point to the known point.

If you are using State Plane Coordinates you can get the same result by converting to latitude and longitude, single proportioning the latitudes and longitudes, and then converting back to state plane. This method can be used as a check that the above formula gives the right answer. When you use latitude and longitude it is important to work with sufficient numbers of decimal places. A hundredth of a foot is about 0.000000028 degrees of latitude. So you need to work with at least 8 decimal places. Converting from degrees, minutes, and decimal seconds to decimal seconds only will help to attain the required precision.

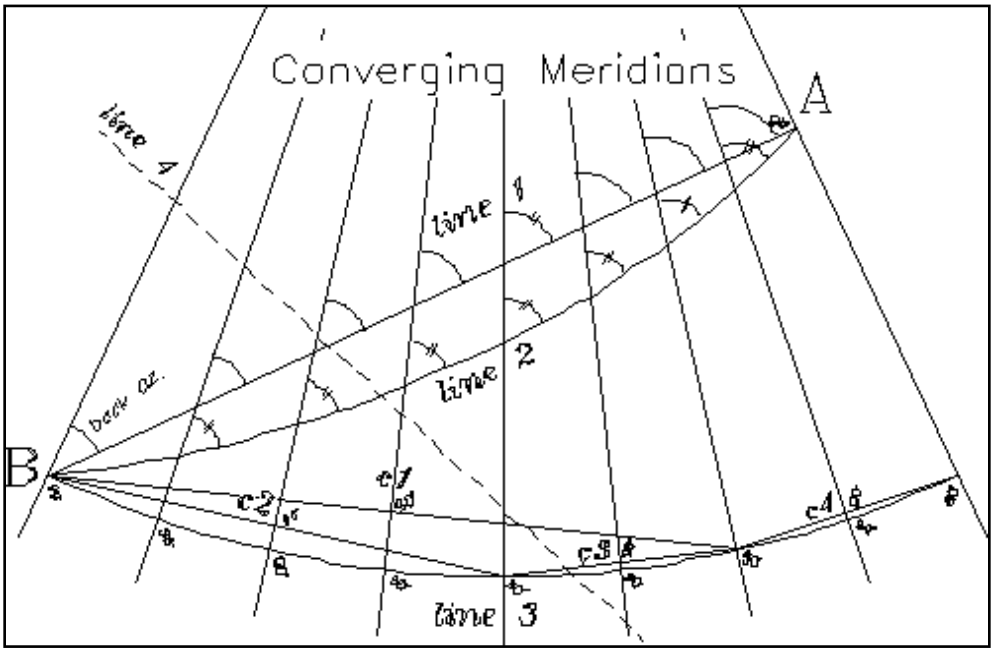


Figure 24

Latitudinal Curve Example

Township 3 North, Range 12 East, Klickitat County, Washington

The section corner, A13, needs to be single proportioned between corners A11 and A15. The GLO distances are exactly 40 chains each from A11 to A13 and A13 to A15. The bearing is east.

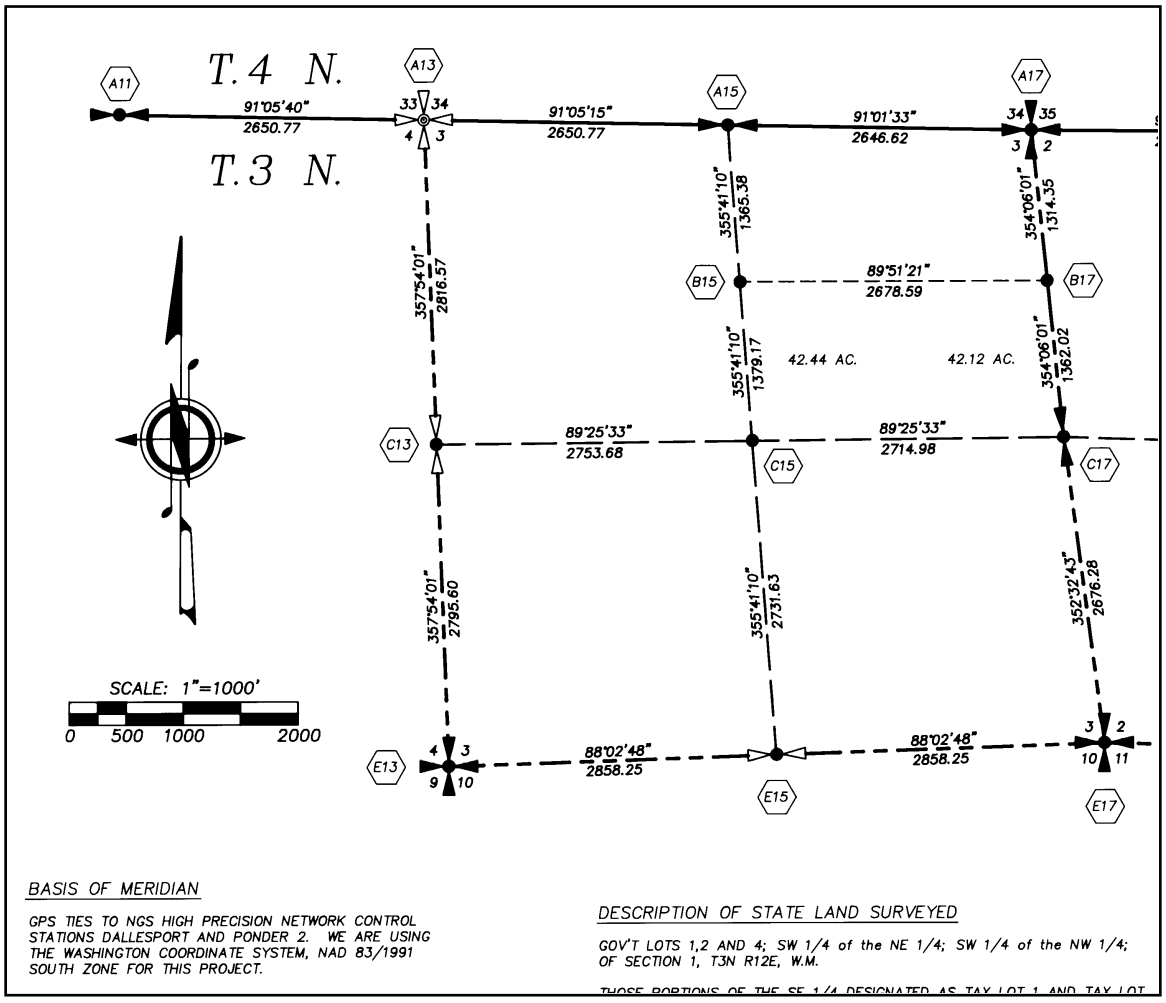


Figure 25

Below "x" is the proportioned point on a straight line.

A11 165014.6400 1433246.1360
S88°54'33"E 2650.770
x 164964.1716 1435896.4260
S88°54'33"E 2650.770
A15 164913.7032 1438546.7160

Use the Corps of Engineers program Corpscon to compute the latitude and the convergence at the single proportioned midpoint. See Figure 26 below.

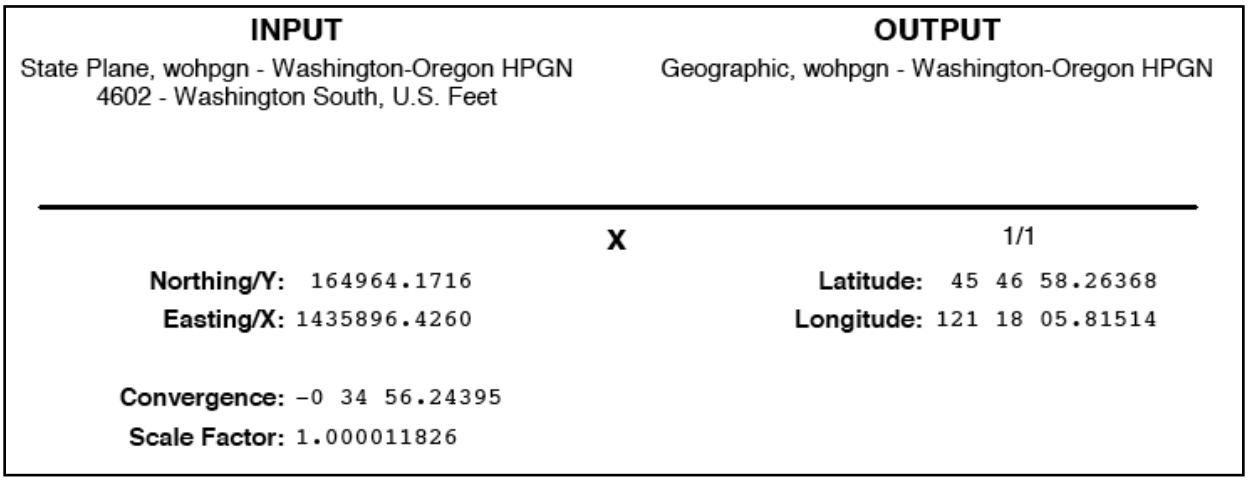


Figure 26

Now compute the offset to latitudinal curve.
Offset = (0.6668) (LW) (LE) (Tan Latitude)
= (0.6668) (2650.77 / 5280) (2650.77 / 5280) (tan 45°46’58”) = 0.1727 feet

Bearing of Offset is cardinal.
Calculate Offset
x 164964.1716 1435896.4260
S 0°34'56"W 0.1727
A13 164963.9989 1435896.4242

Inverse between Corners
A11 165014.6400 1433246.1360
S88°54'19"E 2650.772
A13 164963.9989 1435896.4242
S88°54'46"E 2650.769
A15 164913.7032 1438546.7160

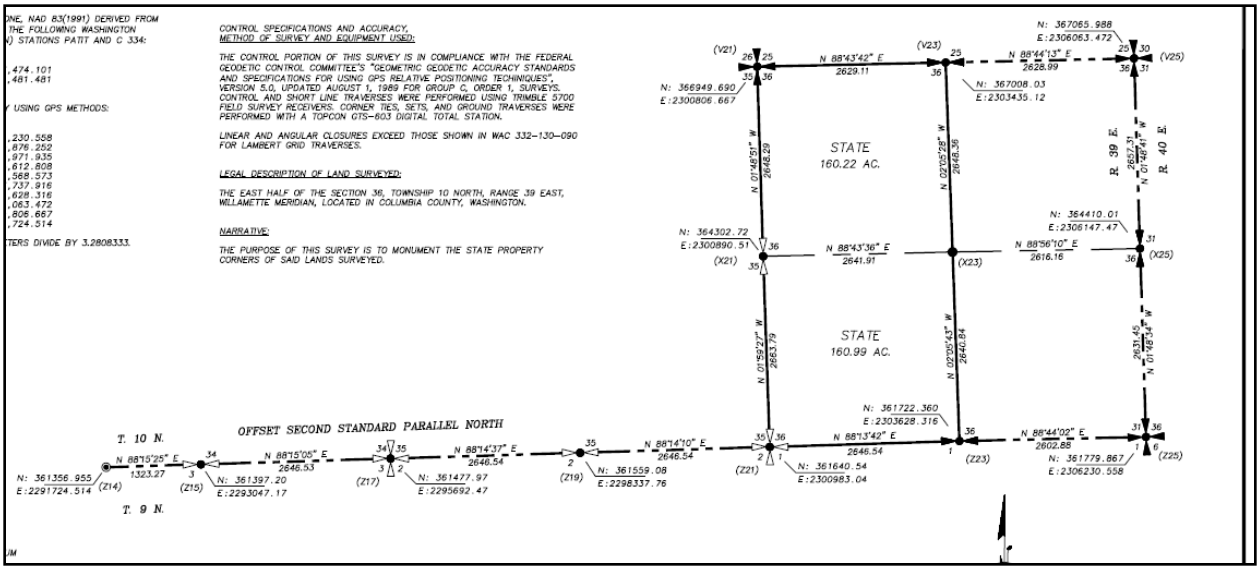
Now calculate the corner using geographic coordinates. First convert to decimal degrees.
A11: 45.782915072 / 121.312004414 A15: 45.782786011 / 121.291226247
A13 is the mean: 45.782850542 / 121.301315331
In degrees, minutes and seconds: 45° 46’ 58.26195” 121° 18’ 05.81519”

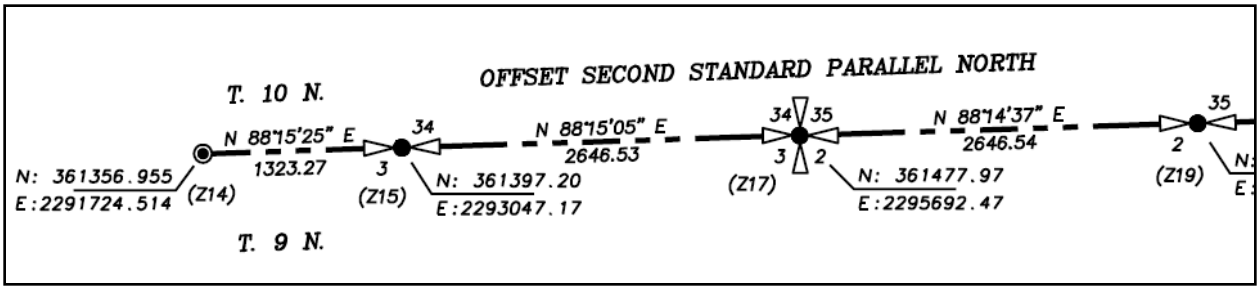
Original Horizontal Coordinates:	wohpgn Geographic	
Translated Horizontal Coordinates:	wohpgn, Washington South - 4602, U.S. Survey Feet	
Name	Input	Output
A13	45 46 58.26195 N	164963.99679 N
	121 18 05.81519 W	1435896.42099 E
Convergence		-00 34 56.24399
Scale Factor		1.000011826

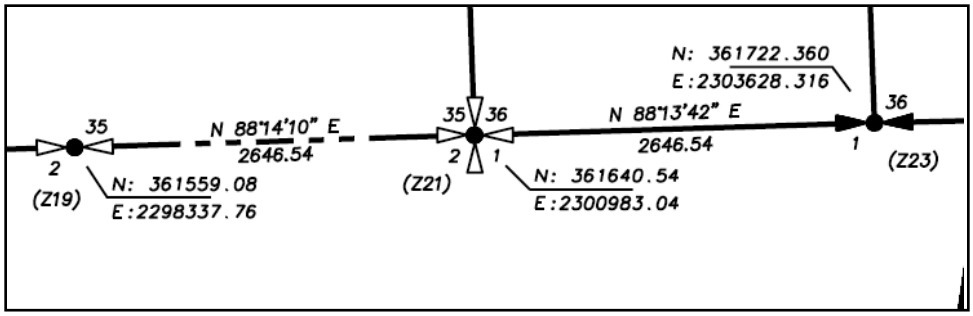
This answer differs from the offset answer by 0.0021 in northing and 0.0032 in easting.

Another Latitudinal Curve Example

The 2.25 miles from corner Z14 to corner Z23 need to be single proportioned along the latitudinal curve. The GLO distance for each mile is 80 chains.







The BLM program WinCMM can be used to perform the calculation.

WinCMM geographic solution

20034
(forward) S. 89°52'16" E. Dist. at mean elevation: 2000.00 ft.
(mean) S. 89°52'09" E. 1323.4901 ft. (20.053 ch)
(reverse) N. 89°52'02" W. Lat: -3.0241 Dep: 1323.4866
440100 = (894)
(forward) S. 89°52'22" E. Dist. at mean elevation: 2000.00 ft.
(mean) S. 89°52'09" E. 2646.9792 ft. (40.106 ch)
(reverse) N. 89°51'55" W. Lat: -6.0464 Dep: 2646.9723
500100 = (895)
(forward) S. 89°52'22" E. Dist. at mean elevation: 2000.00 ft.
(mean) S. 89°52'09" E. 2646.9809 ft. (40.106 ch)
(reverse) N. 89°51'55" W. Lat: -6.0476 Dep: 2646.9740
540100 = (896)
(forward) S. 89°52'22" E. Dist. at mean elevation: 2000.00 ft.
(mean) S. 89°52'09" E. 2646.9817 ft. (40.106 ch)
(reverse) N. 89°51'55" W. Lat: -6.0478 Dep: 2646.9748
600100 = (897)
(forward) S. 89°52'22" E. Dist. at mean elevation: 2000.00 ft.
(mean) S. 89°52'09" E. 2646.9826 ft. (40.106 ch)
(reverse) N. 89°51'55" W. Lat: -6.0469 Dep: 2646.9757
20031

WinCMM state plane inverses

20034
N. 88°15'25" E. 1323.2673 ft. (20.050 ch)
Lat: 40.2490 Dep: 1322.6550
440100 = (894)
N. 88°15'05" E. 2646.5336 ft. (40.099 ch)
Lat: 80.7630 Dep: 2645.3010
500100 = (895)
N. 88°14'37" E. 2646.5353 ft. (40.099 ch)
Lat: 81.1130 Dep: 2645.2920
540100 = (896)
N. 88°14'10" E. 2646.5361 ft. (40.099 ch)
Lat: 81.4640 Dep: 2645.2820
600100 = (897)
N. 88°13'42" E. 2646.5369 ft. (40.099 ch)
Lat: 81.8160 Dep: 2645.2720
20031

Below is the calculation using the Elgin, Knowles & Senne formula.

Single Proportion on a Straight Line

Z14	361356.955 2291724.514	N88°14'30"E 1323.268
Z15T	361397.556 2293047.159	N88°14'30"E 2646.535
Z17T	361478.757 2295692.448	N88°14'30"E 2646.535
Z19T	361559.958 2298337.737	N88°14'30"E 2646.536
Z21T	361641.159 2300983.026	N88°14'30"E 2646.536
Z23	361722.360 2303628.316	

Calculate direction & distance of offsets to the Latitudinal Curve

Z15T 361397.556 2293047.159
Convergence: +1°52'33" S1°52'33"E
(0.6668)*(1323.268/5280)*(2646.535*4/5280)*tan(46°17'42") = 0.351
Z15 361397.205 2293047.170

Z17T 361478.757 2295692.448
Convergence: +1°53'00" S1°53'00"E
(0.6668) * ((1323.268+2646.535) /5280) * (2646.535*3/5280) * tan(46°17'42") = 0.787
Z17 361477.970 2295692.474

Z19T 361559.958 2298337.737
Convergence: +1°53'28" S1°53'28"E
(0.6668) * ((1323.268+2646.535*2) /5280) * (2646.535*2/5280) * tan(46°17'42") = .876
Z19 361559.082 2298337.766

Z21T 361641.159 2300983.026
Convergence: +1°53'55" S1°53'55"E
(0.6668) * ((1323.268+2646.535*3) /5280) * (2646.535/5280) * tan(46°17'42") = 0.614
Z21 361640.545 2300983.047

Inverse between final coordinates

Z14	361356.955 2291724.514	N88°15'25"E 1323.269
Z15	361397.205 2293047.170	N88°15'04"E 2646.536
Z17	361477.970 2295692.474	N88°14'37"E 2646.535
Z19	361559.082 2298337.766	N88°14'10"E 2646.535
Z21	361640.545 2300983.047	N88°13'43"E 2646.534
Z23	361722.360 2303628.316	

Solution using Geographic Coordinates

Z14	Latitude:	46° 17’ 42.31470”
	Longitude:	117° 55’ 22.34649”
Z23	Latitude:	46° 17’ 42.04609”
	Longitude:	117° 52’ 32.73184”

Deltas in seconds:	Latitude	0.26861
	Longitude	169.61465

The total distance is 180 chains.
The proportions are 1/9 delta for 20 chains and 2/9 delta for 40 chains.

The resulting single proportioned coordinates

Z15	Latitude:	46 17 42.28485	Longitude:	117 55 03.50042
	Northing/Y:	361397.204	Easting/X:	2293047.169
Z17	Latitude:	46 17 42.22516	Longitude:	117 54 25.80828
	Northing/Y:	361477.966	Easting/X:	2295692.470
Z19	Latitude:	46 17 42.16547	Longitude:	117 53 48.11614
	Northing/Y:	361559.080	Easting/X:	2298337.762
Z21	Latitude:	46 17 42.10578	Longitude:	117 53 10.42400
	Northing/Y:	361640.544	Easting/X:	2300983.043

ii. Double Proportion

From the BLM Manual of Surveying Instructions, 1973:

5-25. *Lengths of proportioned lines are comparable only when reduced to their cardinal equivalents.*

5-26. *In order to restore a lost corner of four townships, a retracement will first be made between the nearest known corners on the meridional line, north and south of the missing corner, and upon that line a temporary stake will be placed at the proper proportionate distance; this will determine the latitude of the lost corner.*

Next, the nearest corners on the latitudinal line will be connected, and a second point will be marked for the proportionate measurement east and west; this point will determine the position of the lost corner in departure (or longitude).

Then, through the first temporary stake run a line east or west, and through the second temporary stake a line north or south, as relative situations may determine; the intersection of these two lines will fix the position for the restored corner.

Figure 27 below illustrates the plan of double proportionate measurement. Points A, B, C, and D represent four original corners which will control the restoration of the lost corner X. On the large scale diagram the point E represents the proportional measurement between A and B, and similarly, the point F represents the proportional measurement between C and D. The point X satisfies the first control for latitude and the second control for departure.

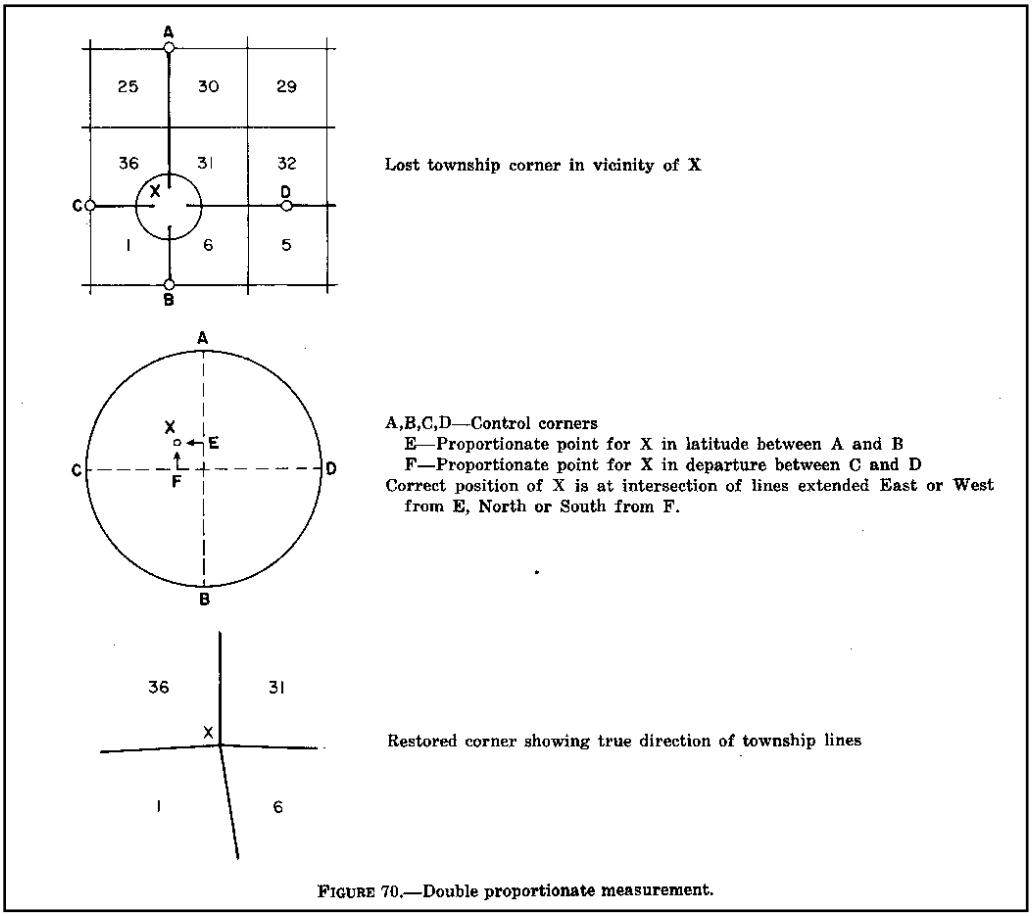


FIGURE 70.—Double proportionate measurement.

Figure 27

Double Proportion Example

Section 16, T30N, R44E, W.M., Pend Oreille County, Washington

Basis of Bearings and Coordinates: NAD83, 1991 adjustment.

This survey computes a double proportion position for corner N9, the southwest corner of Section 16. See Figure 28 below for the survey and Figure 29 on page 45 for the GLO plat with original measurements to use for proportioning.

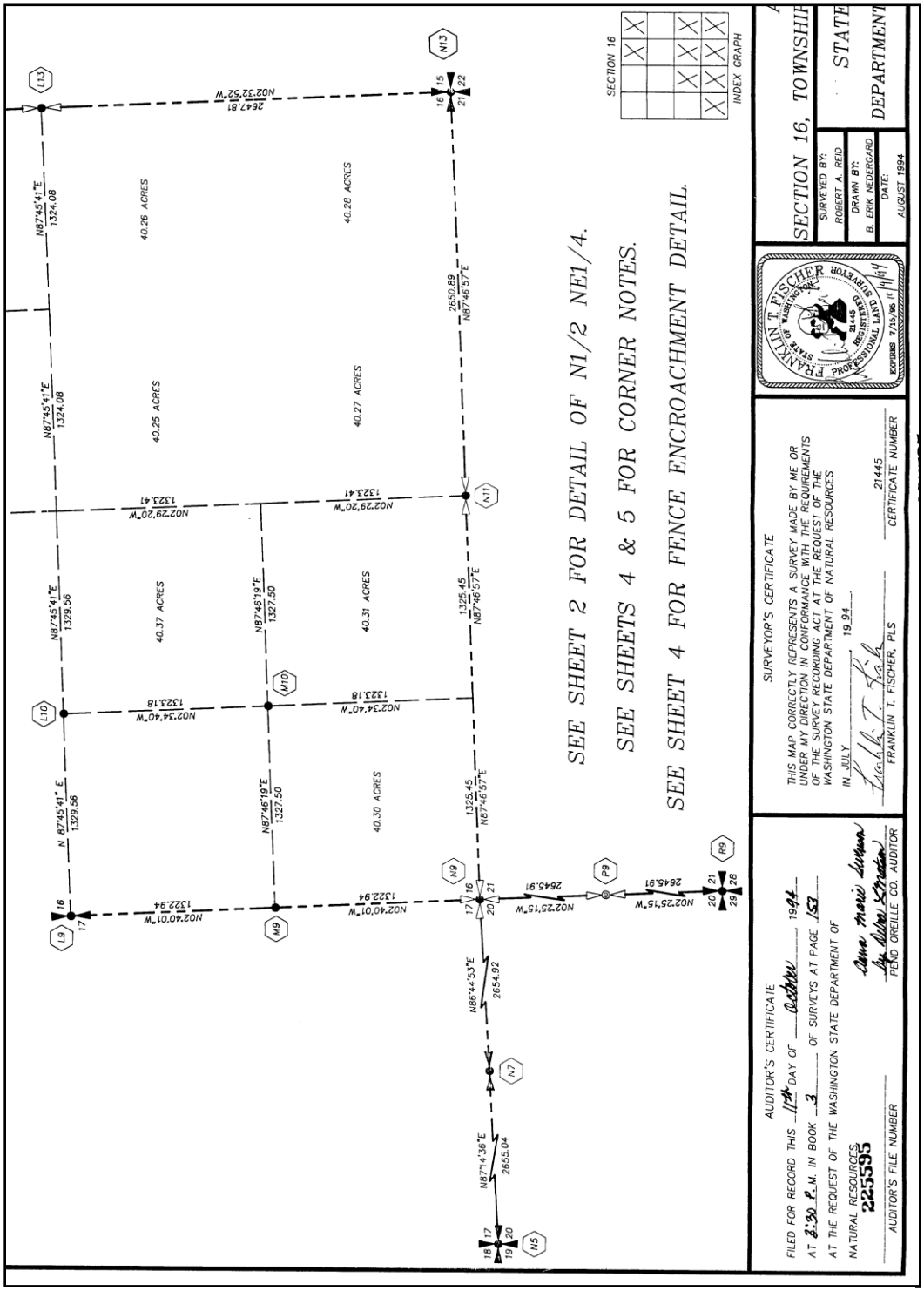


Figure 28

Plat of 1902 GLO Survey by Scurry and Owens

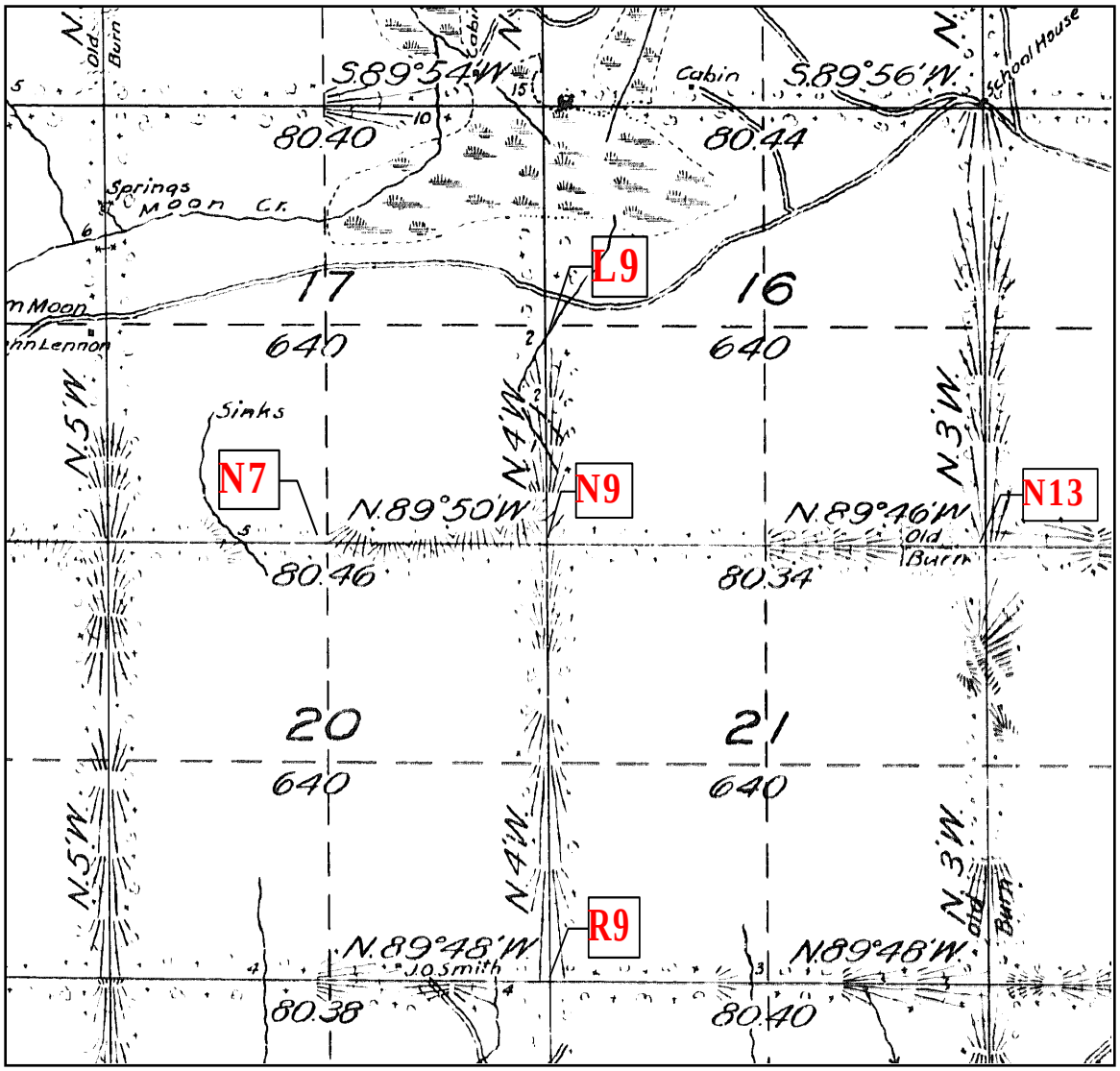


Figure 29

Cardinal Equivalents of East-West Lines:

N89°46'W, 80.34 chs: Lat. +0.3272, Dep. -80.3393

N89°50'W, 40.23 chs: Lat. +0.1170, Dep. -40.2298

Total Departure for E-W proportioning: 120.5691 chs.

Cardinal Equivalents of North-South Lines:

N00°04'W, 80.00 chs: Lat. +79.9999, Dep. -0.0931

N00°04'W, 40.00 chs: Lat. +40.0000, Dep. -0.0465

Total Latitude for N-S proportioning: 119.9999 chs.

Coordinates of controlling corners:
L9: 420362.066 / 2512679.621
N7: 417568.444 / 2510152.087
N13: 417924.181 / 2518100.550
R9: 412431.941 / 2513026.260

Calculate the temporary positions:
L9 to R9 = S 2°30'10"E 7937.697 feet measured, 120.000 chains GLO.
N7 to N13 = N87°26'15"E 7956.420 feet measured, 120.569 chains GLO.
North/South proportion = 7937.697 / 120.000 = 66.1641 feet per chain.
North/South distances are 40 x 7937.697/120 = 2645.899
and 80 x 7937.697/120 = 5291.798
East/West proportion = 7956.420 / 120.569 = 65.9906 feet per chain.
East/West distances are 40.230 x 7956.420 / 120.569 = 2654.802
and 80.339 x 7956.420 / 120.569 = 5301.618

L9 420362.0660 2512679.6210
S 2°30'10"E 2645.899
y 417718.6912 2512795.1673 <- temporary north south point
S 2°30'10"E 5291.798
R9 412431.9410 2513026.2600

N7 417568.4440 2510152.0870
N87°26'15"E 2654.780
x 417687.1410 2512804.2122 <- temporary east west point
N87°26'15"E 5301.640
N13 417924.1810 2518100.5500

Calculate convergence at the temporary positions:
y 417718.69120 N
2512795.16730 E
Convergence 02 39 30.79525 Scale Factor 0.999942375
x 417687.14100 N
2512804.21220 E
Convergence 02 39 30.87829 Scale Factor 0.999942375

Calculate the grid direction of a cardinal offset at the temporary positions:
The grid Azimuth = true azimuth minus convergence.
True north 0° = grid 357°20’29” = N 2°39’31”W
In most of eastern Washington convergence is positive.
In most of western Washington convergence is negative.

Intersection of cardinal lines from temporary points:

Pt	Bearing	Distance	Pt
x	N 2°39'31"W	31.936	z
y	N87°20'29"E	7.572	z

Double Proportion Solution:

z = 417719.0424 2512802.7308

L9 to z = S 2°40'01"E 2645.889

N7 to z = N86°44'53"E 2654.919

N13 to z = S87°46'57"W 5301.789

R9 to z = N 2°25'15"W 5291.824

iii. One Point Control

BLM Manual 5-45. Original Control

Where a line has been terminated with measurement in one direction only, a lost corner will be restored by record bearing and distance, counting from the nearest regular corner, the latter having been duly identified or restored.

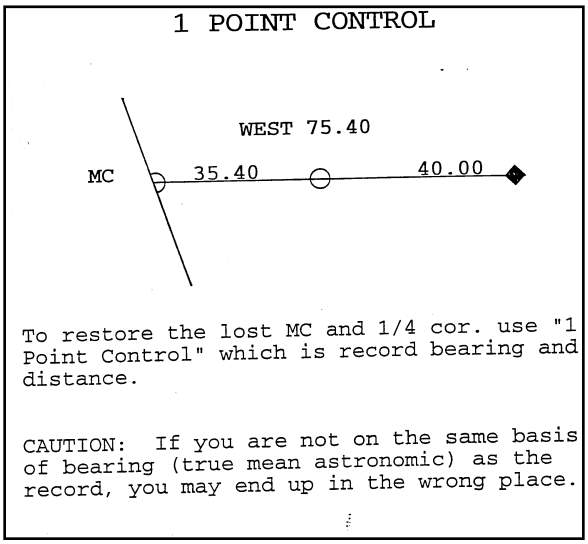


Figure 30

iv. Two Point Control

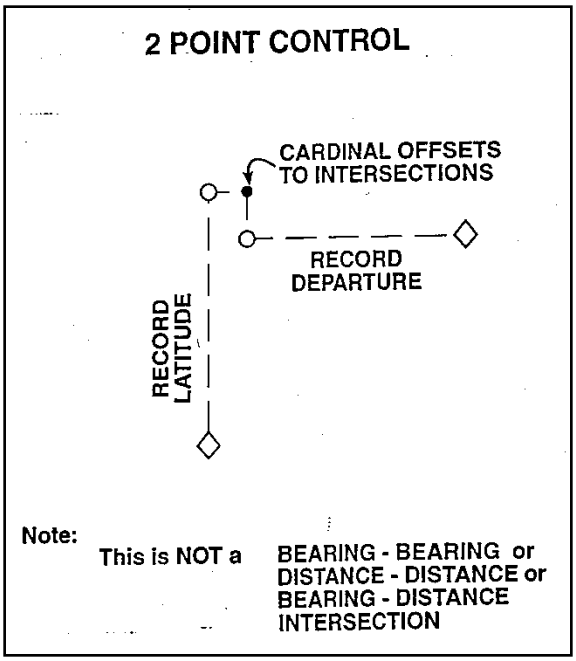


Figure 31

v. Three Point Control

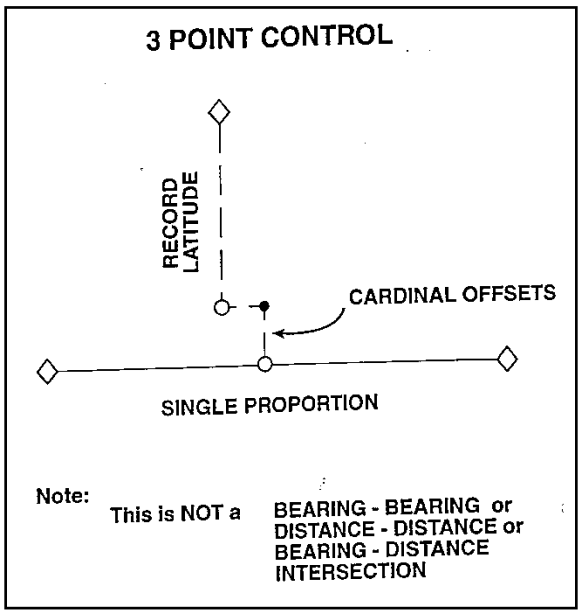


Figure 32

One Point Control Example
Section 32, T31N, R1W, W.M.

Washington Coordinate System, North Zone, NAD 83(1986)
Combined Grid Scale Factor is 0.9999361

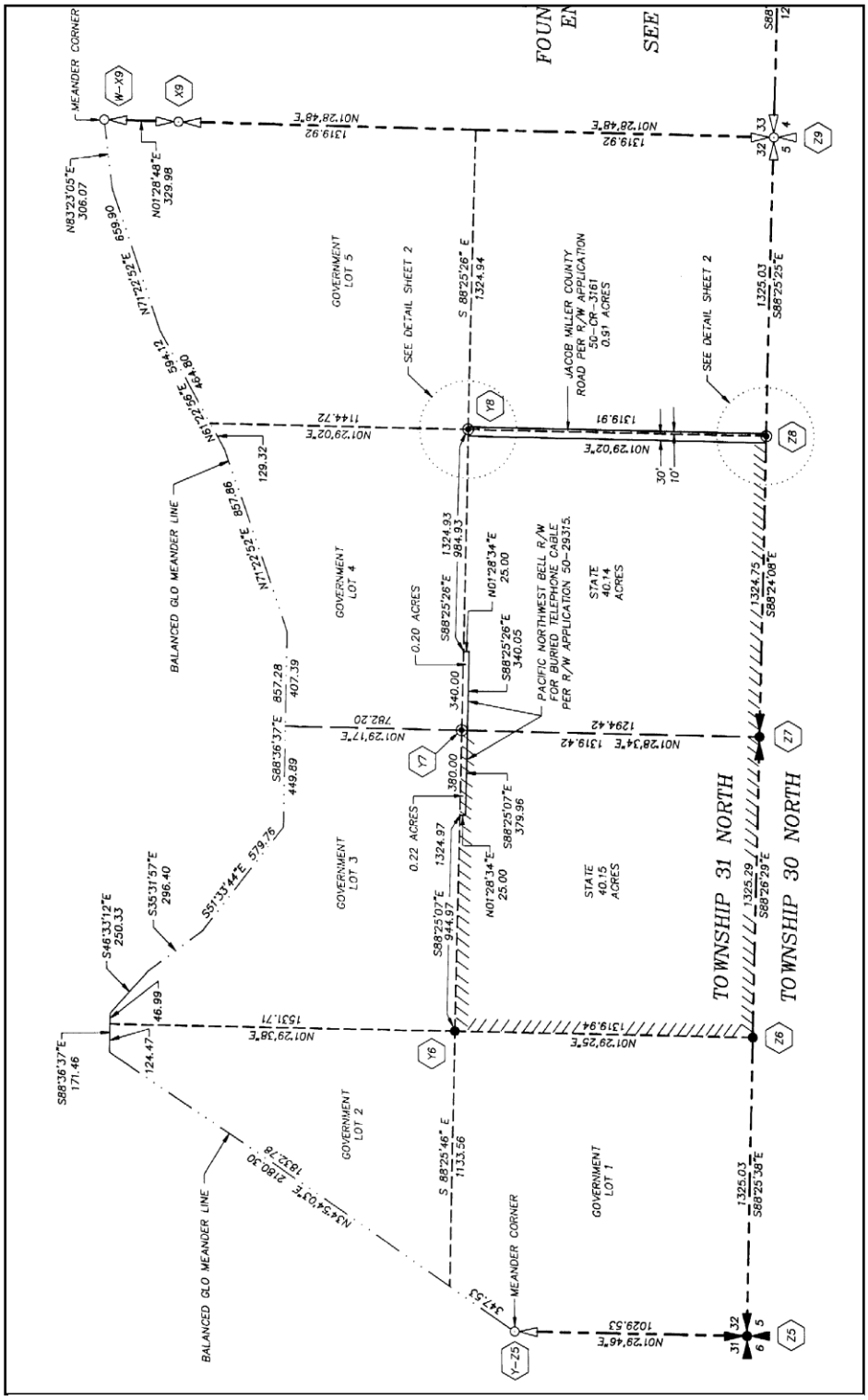


Figure 33

GLO Plat of Township 31 North, Range 1 West, W.M.

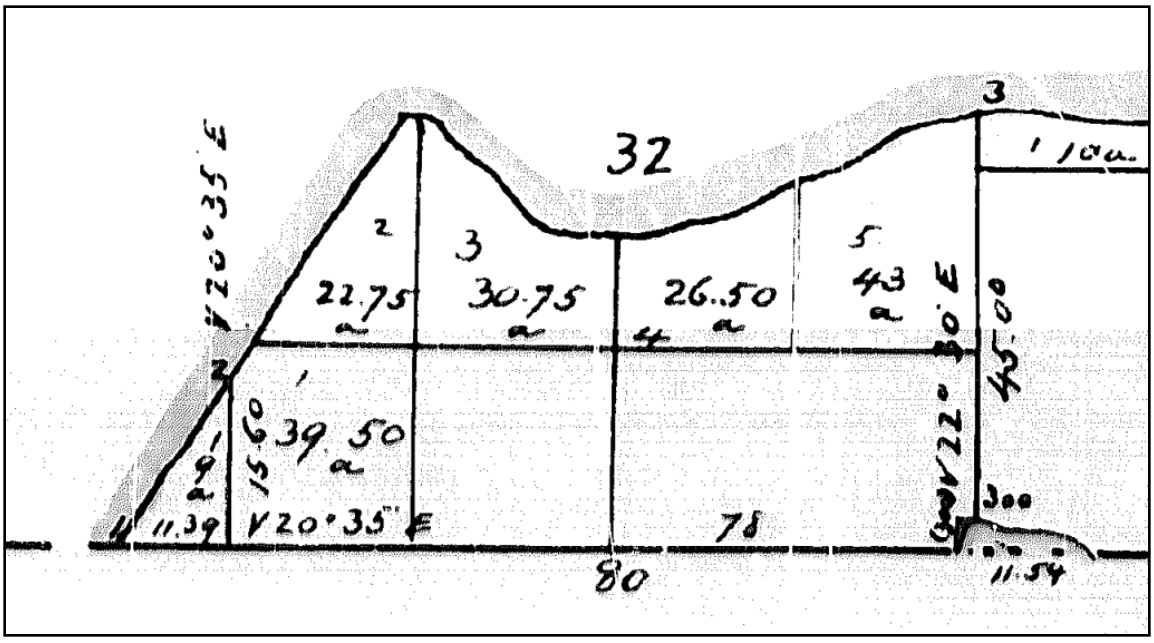


Figure 34

Calculate the two lost meander corners for Section 32 by one point control.

BLM Manual 5-45. Original Control

> *Where a line has been terminated with measurement in one direction only, a lost corner will be restored by record bearing and distance, counting from the nearest regular corner, the latter having been duly identified or restored.*

First Figure the convergence angle at the two controlling section corners.

Original Horizontal Coordinates: NAD 83, Wash North - 4601, U.S. Survey Feet
Translated Horizontal Coordinates: NAD 83 Geographic

Name	Input	Output
Z5	418066.52830 N	48 07 42.75348 N
	1149715.80420 E	122 50 34.43272 W
Convergence		-01 29 46.18221
Scale Factor		0.999942271

Z9	417920.73130 N	48 07 42.67294 N
	1155013.89900 E	122 49 16.30200 W
Convergence		-01 28 48.01230
Scale Factor		0.999942271

Elevation scale factor is 0.9999938.
Combined grid scale factor is 0.9999361.

From Z5 the meander corner is N 1°29’46”E, 1029.53 feet.
0.9999361 x 15.60 chains x 66 ft/ch = 1029.53.
From Z9 the 1/4 corner, X9, is N 1°28’48”E, 2639.83 feet.
0.9999361 x 40 chains x 66 ft/ch = 2639.83.
From the 1/4 corner, X9, the meander corner is N 1°28’48”E 329.98 feet.
0.9999361 x 5 chains x 66 ft/ch = 329.98.

Three Point Control Example
GLO Plat T 29N, R2W, W.M.

The line between sections 27 and 34 was only partially measured. The section line monument 35.00 chains west of the corner of sections 26, 27, 34, and 35 is lost. The restoration of the section corner of sections 26, 27, 34 and 35 is done by three point control using the nearest found corners north, east and south.

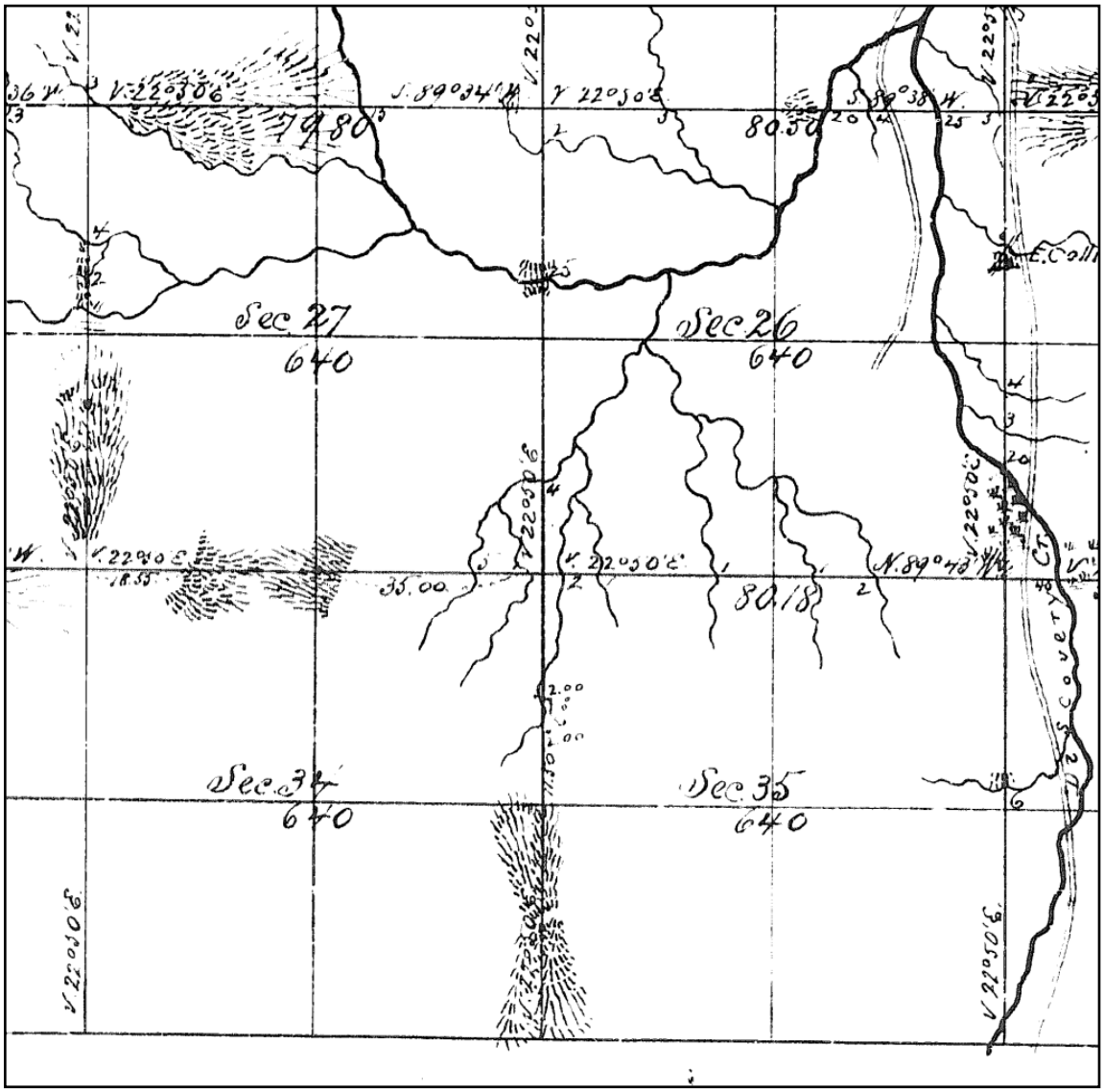


Figure 35

3 Way Proportion of the Southwest corner of Section 26

Basis of Bearings: Washington Coordinate System, North Zone, NAD 27.

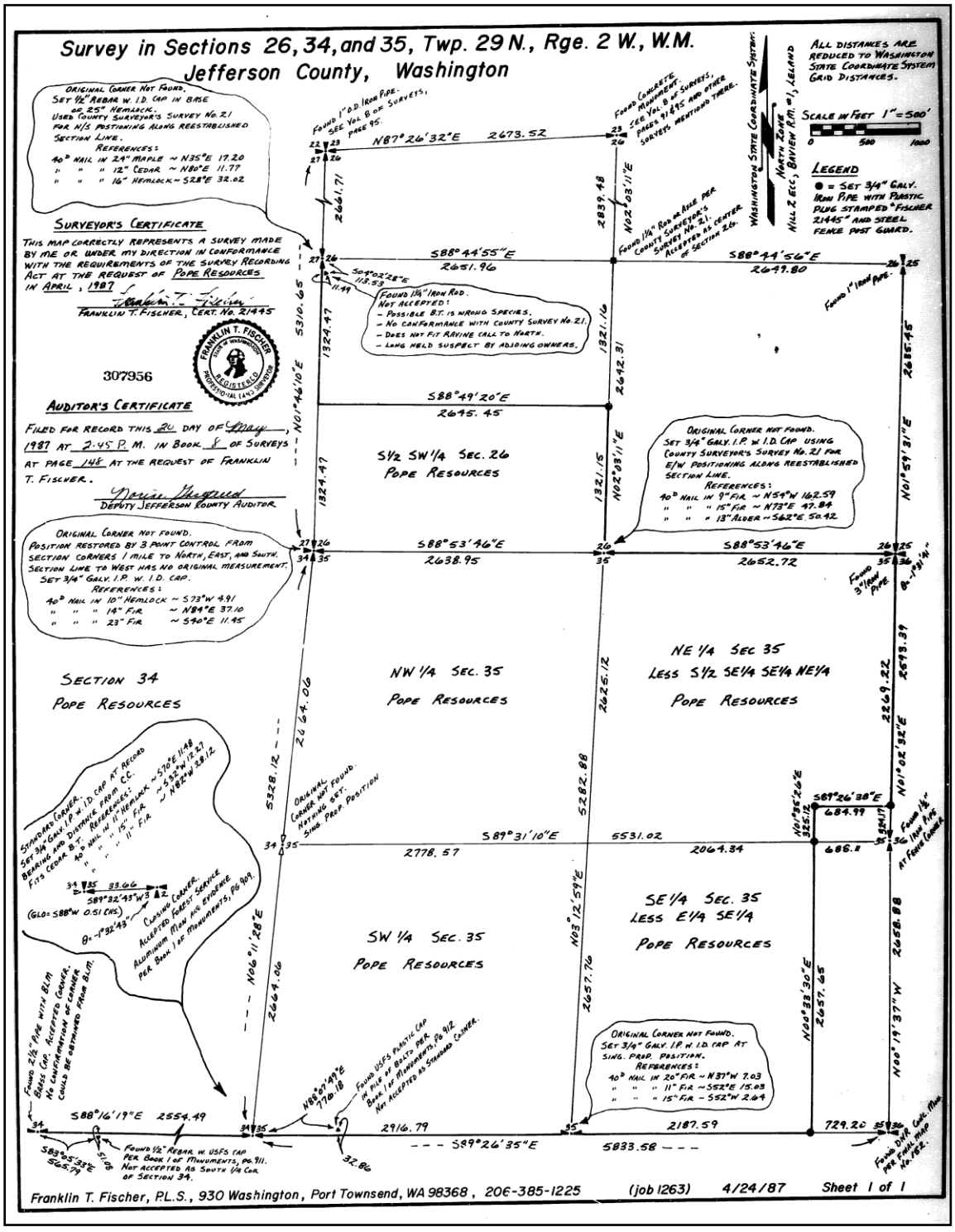


Figure 36

First the coordinates of the controlling corners.
Original Horizontal Coordinates: NAD 27, Washington North - 4601, U.S. Survey Feet
Translated Horizontal Coordinates: NAD 27 Geographic
Southwest corner of section 35
337 355018.64700 N 47 57 16.09267 N
1491453.45600 E 122 54 32.10787 W
Convergence -01 32 43.13628 Scale Factor 0.999946308
Northwest corner of section 26
3252 365623.81400 N 47 59 00.91475 N
1492192.04300 E 122 54 25.45892 W
Convergence -01 32 38.18601 Scale Factor 0.999944993
Northeast corner of section 35
83 360213.74000 N 47 58 08.89751 N
1497318.74600 E 122 53 08.00494 W
Convergence -01 31 40.51994 Scale Factor 0.999945613

The north and south proportion:
This is a midpoint because the GLO measure is 80 chains for each mile.
337 355018.6470 1491453.4560
N 3°59'02"E 5315.427
x 360321.2305 1491822.7495 <- temporary point north and south
N 3°59'02"E 5315.427
3252 365623.8140 1492192.0430

Single point control from NE corner of Section 35:
GLO is N89°40'W, 80.18 chains. The cardinal equivalent is sin(89°40') * 80.18 = 80.1786 chs. = 5291.503 feet. We are close to sea level so apply convergence of –1°31'41" and scale factor of 0.9999456.
83 360213.74000 1497318.7460 N88°28'19"W 5291.503
y 360354.846 1492029.125 <- temporary point east and west

Now compute convergence and do cardinal intersection.
Y 360354.846 N 1492029.125 E
Convergence -01 32 38.41461 Scale Factor 0.999945614
x 360321.231 1491822.749 S88°27'22"E 209.095
z 360315.697 1492028.070 N 1°32'38"E 39.163
y 360354.846 1492029.125

Inverse to controlling corners.
z 360315.6968 1492028.0636
S88°53'46"E 5291.665 to 83: 360213.74000 1497318.7460
S 6°11'28"W 5328.125 to 337: 355018.64700 1491453.4560
N 1°46'10"E 5310.649 to 3252: 365623.81400 1492192.043

vi. Meander Lines and Grant Boundaries

Donation Land Claims don't have a defined rule although the Grant boundary method might seem the more logical choice.

Rotate and scale Grant Boundaries.

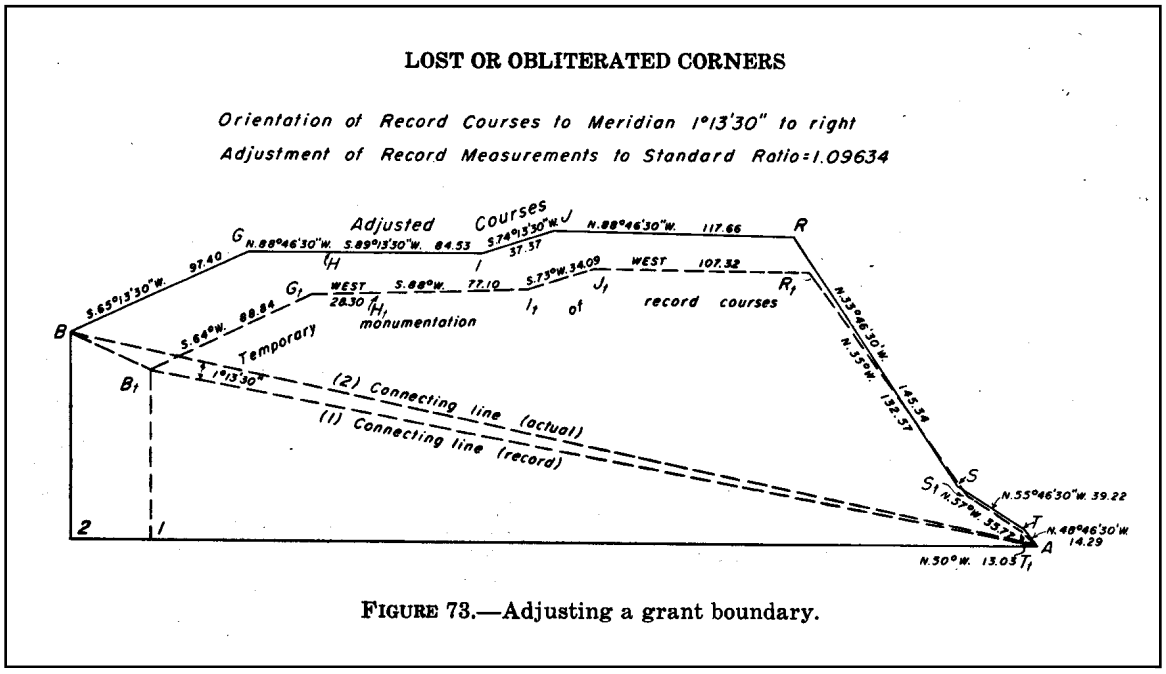


FIGURE 73.—Adjusting a grant boundary.

Figure 37

Use the compass rule for Meander Lines.

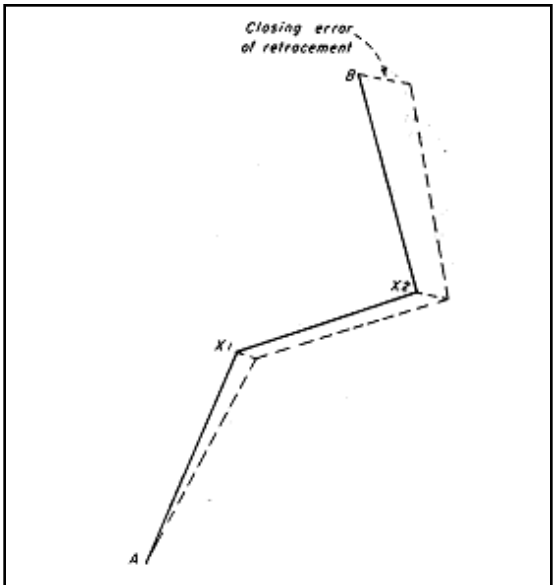


FIGURE 72.—Adjusting angle points on a nonriparian meander line.

Figure 38

Meander Line Adjustment Example
Section 16, T16N, R11W, W.M.

GLO Plat

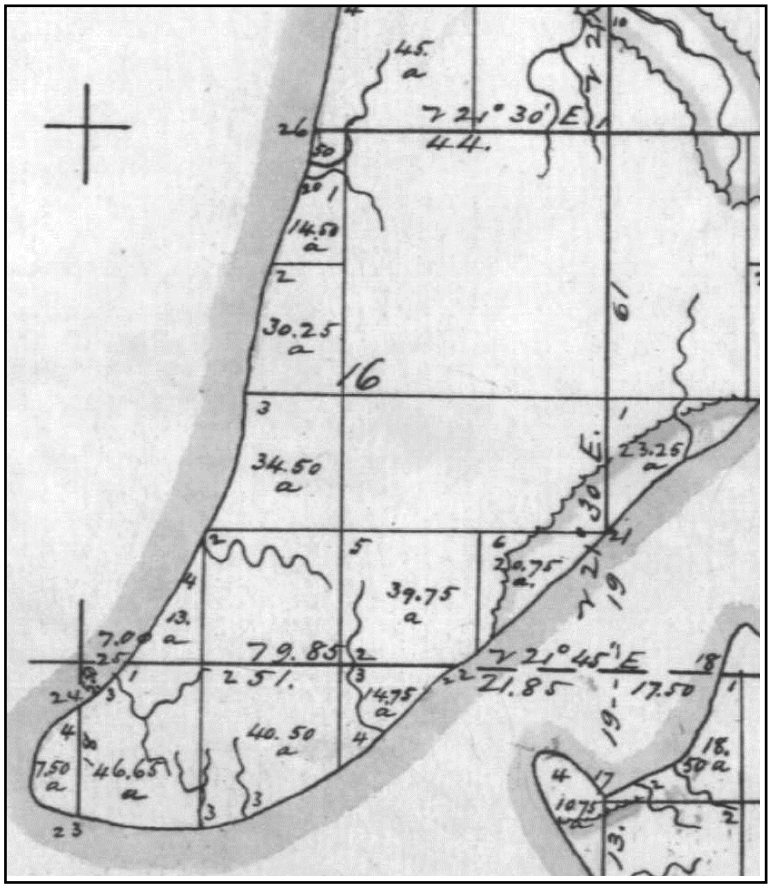
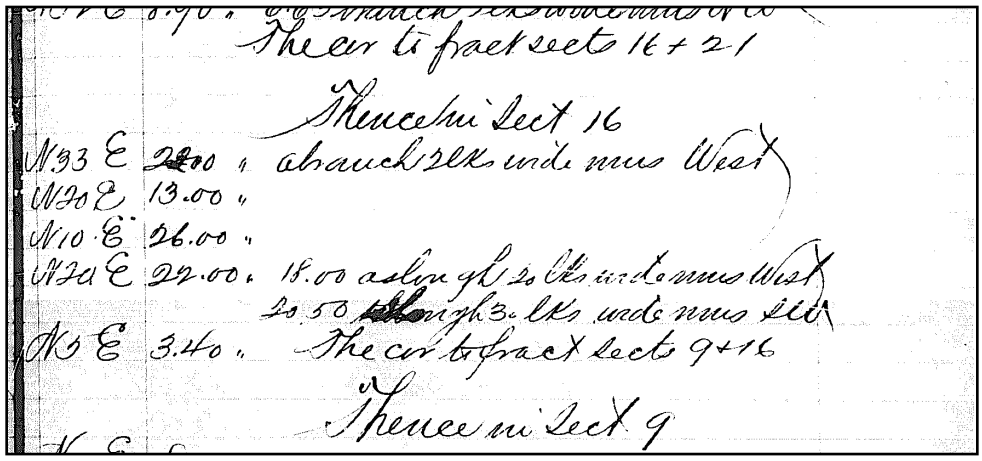


Figure 39

GLO Notes for Meander Line on West side of Section 16.


The cor to fract sects 16 + 21

Thence on Sect 16

N 33 E 24.00 " a branch 21 Lks wide runs West

N 30 E 13.00 "

N 10 E 26.00 "

N 22 E 22.00 " 18.00 a stn 9 Lks wide runs West
20.50 a stn 3 Lks wide runs East

N 5 E 3.40 " The cor to fract sects 9 + 16

Thence on Sect 9

Figure 40

Survey in Section 16, T16N, R11W, W.M.

Washington Coordinate System, South Zone, NAD83/91

Combined Scale Factor 0.9999302

Coordinates are in meters. Multiply by 3.2808333333333 to get US Survey feet.

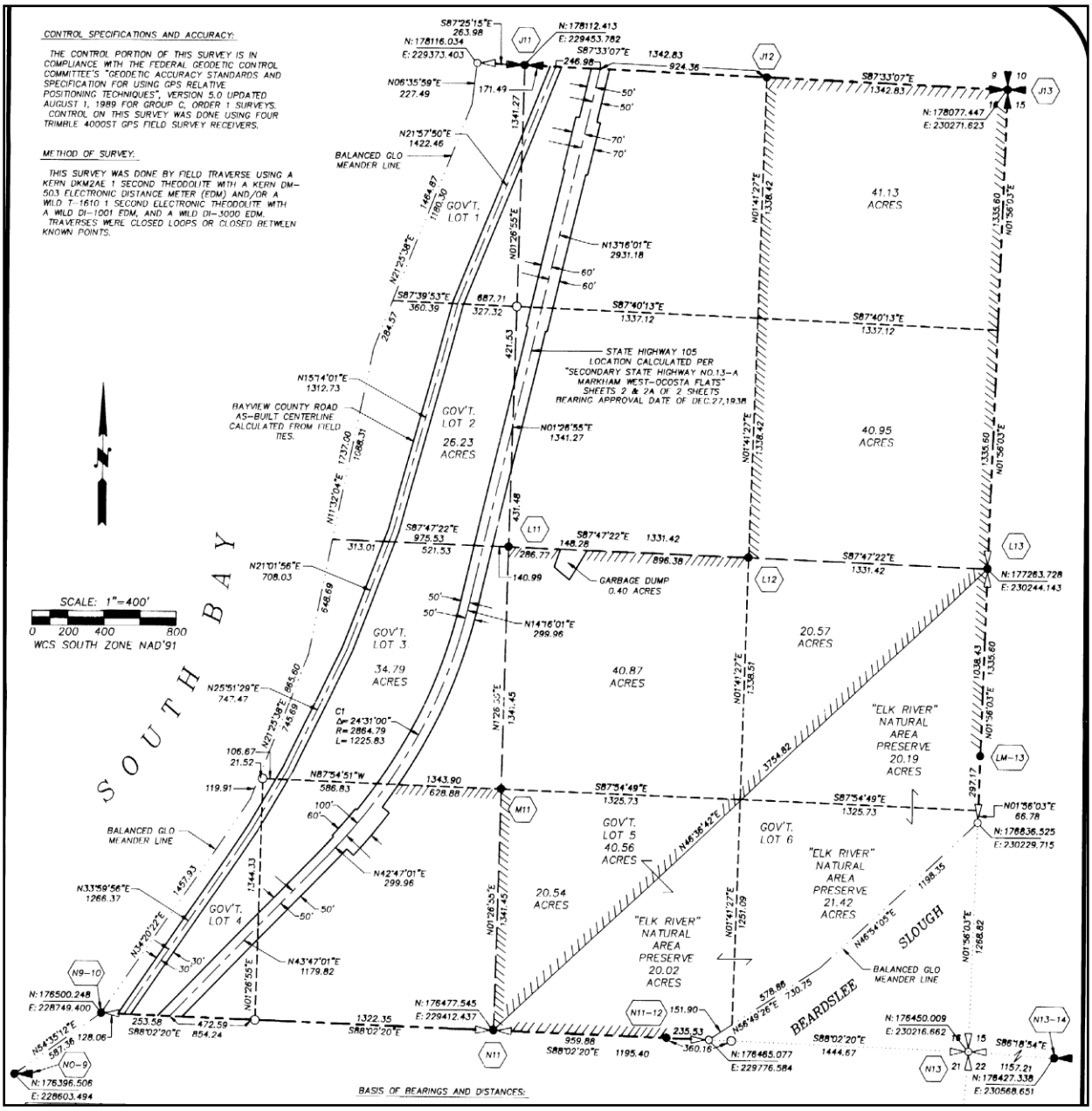


Figure 41

There can be several way to approach the adjustment of the meander line of Section 16, R16N, R11W. The critical part of any procedure is to run out the GLO record and the apply a compass adjustment.

First enter the record courses using GLO bearings and distances scaled by the combined scale factor of 0.9999302.

2 579067.8960 750488.6570 N33°00'00"E 1451.900 (22.00 chains)
24 580285.5618 751279.4184 N20°00'00"E 857.940 (13.00)
25 581091.7617 751572.8512 N10°00'00"E 1715.880 (26.00)
26 582781.5736 751870.8106 N20°00'00"E 1451.900 (22.00)
27 584145.9133 752367.3897 N 5°00'00"E 224.380 (3.40)
28 584369.4395 752386.9457

Next rotate by convergence at the meander corner between sections 16 and 21.

Original Horizontal Coordinates: Wohpgn, Washington South - 4602, U.S. Survey Feet
Translated Horizontal Coordinates: Wohpgn Geographic
MC 16/21 579067.89600 N 46 51 58.31630 N
750488.65700 E 124 03 32.60205 W
Convergence -02 35 07.02011 Scale Factor 0.999926616

---

2 579067.8960 750488.6570 N35°35'07"E 1451.900
24 580248.6541 751333.5380 N22°35'07"E 857.940
25 581040.7978 751663.0368 N12°35'07"E 1715.880
26 582715.4500 752036.9141 N22°35'07"E 1451.900
27 584056.0022 752594.5280 N 7°35'07"E 224.380
28 584278.4188 752624.1466 N44°14'39"W 126.472 <- misclosure
15 584369.0200 752535.9050

Next, adjust using the compass rule.

2 579067.8960 750488.6570 N34°20'22"E 1457.931
24 580271.7239 751311.0690 N21°25'38"E 865.604
25 581077.4997 751627.2907 N11°32'04"E 1736.995
26 582779.4162 751974.6139 N21°25'38"E 1464.870
27 584143.0382 752509.7589 N 6°35'59"E 227.489
28 584369.0200 752535.9050 N45°00'00"W 0.000
15 584369.0200 752535.9050

vii. Irregular Exterior Boundary Calculation

1973 BLM Manual Section 5-36 Along Irregular Township Exteriors

> *5-36. Some township boundaries, not established as straight lines, are termed "irregular" exteriors. Parts were surveyed from opposite directions and the intermediate portion was completed later by random and true line, leaving a fractional distance. Such irregularity follows some material departure from the basic rules for the establishment of original surveys. A modified form of single proportionate measurement is used in restoring lost corners on such boundaries. This is also applicable to a section line or a township line which has been shown to be irregular by a previous retracement.*
>
> *In order to restore one or more lost corners or angle points on such irregular exteriors, a retracement between the nearest known corners is made on the record courses and distances to ascertain the direction and length of the closing distance. A temporary stake is set for each missing corner or angle point. The closing distance is then reduced to its equivalent latitude and departure.*
>
> *On a meridional line the latitude of the closing distance is distributed among the courses in proportion to the latitude of each course. The departure of the closing distance is distributed among the courses in proportion to the length of each course. That is, after the excess or deficiency of latitude is distributed, each temporary stake is moved east or west an amount proportional to the total distance from the starting point.*
>
> *On a latitudinal line the temporary stakes should be placed to suit the usual adjustments for the curvature. The departure of the closing distance is distributed among the courses in proportion to the departure of each course. Then each temporary stake is moved north or south an amount proportional to the total distance from the starting point.*
>
> *Angle points and intermediate corners will be treated alike.*

Irregular boundaries are sometimes found inside of a township when there is a retracement during the course of a completion survey.

In order to apply the above methodology the basis of bearing has to be true because the latitudes are adjusted in a different manner from the departures. In a federal survey the latitudes and departures are always with reference to true astronomic meridian; they are not relative to any plane coordinate system.

Except in unusual circumstances, where the record survey lines differ significantly from cardinal, the BLM method for adjusting an irregular boundary produces close to the same results as a compass rule adjustment of the record boundaries.

1912 GLO Plat of T33N, R9E

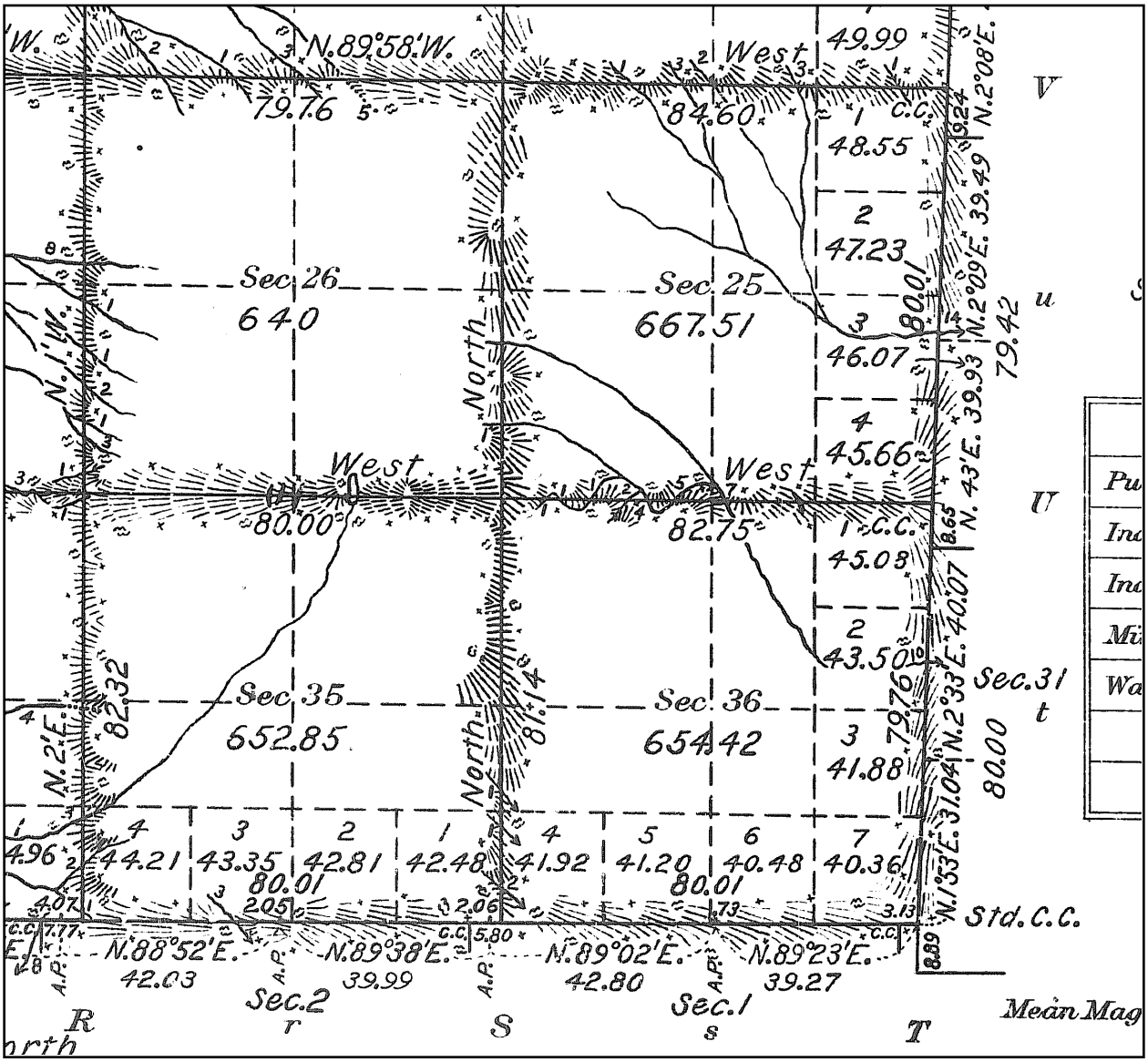


Figure 42

The southeast corner of section 36 (Z25) and the standard section corner of sections 30 and 31 (V1) were found. The lost west quarter corner of section 31 needs to be proportioned using the irregular boundary method. The coordinate system of the survey in Washington Coordinate System, North Zone, NAD 83 (1991). The combined scale factor in 0.99994797.

First use Corpscon to get the convergence angle at the southeast corner of section 36.

Original Horizontal Coordinates: Wohpgn, Washington North - 4601, Meters
Translated Horizontal Coordinates: Wohpgn, Washington North - 4601, U.S. Survey Feet
Z25 144690.15800 N 474704.29337 N
444791.69600 E 1459287.42263 E
Convergence: -00 33 14.56976 Scale Factor: 0.999947237

Inverse between the found corners.
Z25 474704.2934 1459287.4226
N 2°42'47"E 4679.271 <- grid inverse
V1 479378.3195 1459508.9215

Rotate -0°33’15” at Z25 to make the basis bearings true at corner Z25.
Z25:1 474704.2934 1459287.4226
N 2°09'32"E 4679.271
V1:1 479380.2431 1459463.7045

Run the GLO record from Z25 to V1, using the combined scale factor of 0.99992952.
Z25:1 474704.2934 1459287.4226 N 1°53'00"E 2048.500 (31.04 chains)
a 476751.6868 1459354.7455 N 2°33'00"E 2644.430 (40.07 chains)
b 479393.4982 1459472.3993 S 0°00'00"E 13.255 (northing miss)
c 479380.2431 1459472.3993 S90°00'00"W 8.695 (easting miss)
V1:1 479380.2431 1459463.7045

Distribute latitudinal (northing) error based on the latitude (northing) of each course.
Total latitude: northing of “b” minus northing of Z25:1 = 4689.2048
1st course: northing of “a” minus northing of Z25:1 = 2047.3934
2nd course: northing of “b” minus northing of “a” = 2641.8114
Adjustment to northing of “a” : -(2047.3934 / 4689.2048 x 13.255) = -5.787
Adjustment to northing of “b” : -13.255

Distribute the departure (easting) error based on the length of each course.
Total length: 2048.500 + 2644.430 = 4692.930
Adjustment to the easting of “a”: -(2048.500 / 4692.930 x 8.695) = -3.795
Adjustment to the easting of “b”: -8.695

a: 476751.687 – 5.787 = 476745.900
1459354.745 – 3.795 = 1459350.950
b: = V1:1

Adjusted GLO record
Z25:1 474704.2934 1459287.4226 N 1°46'56"E 2042.595
a 476745.9000 1459350.9500 N 2°27'03"E 2636.755
V1:1 479380.2431 1459463.7045

Rotate 0°33’15” at Z25 to make bearings grid.
Z25:1 474704.2934 1459287.4226 N 2°20'11"E 2042.595
a 476745.1901 1459370.6932 N 3°00'18"E 2636.755
V1:1 479378.3195 1459508.9215

Alternatively, rotate the GLO record to grid and try a simple compass adjust.
Rotate record 0°33’15” at Z25 to make bearings grid.

N 1°53'00"E 2048.500 (31.04 chains) Rotated is N 2°26’15”E
N 2°33'00"E 2644.430 (40.07 chains) Rotated is N 3°06’15”E

Raw Traverse:
Z25 474704.2934 1459287.4226 N 2°26'15"E 2048.500
x 476750.9399 1459374.5445 N 3°06'15"E 2644.430
y 479391.4898 1459517.7441 S33°49'03"W 15.852 <- misclosure
V1 479378.3195 1459508.9215

Balanced:
Z25 474704.2934 1459287.4226 N 2°20'11"E 2042.596
x 476745.1909 1459370.6933 N 3°00'18"E 2636.754
y 479378.3195 1459508.9215 N 0°00'00"E 0.000
V1 479378.3195 1459508.9215

The modified single proportion procedure and the compass adjust produce the same results.
a: 476745.1901 1459370.6932
x: 476745.1909 1459370.6933

5. Proportioning is a Last Resort

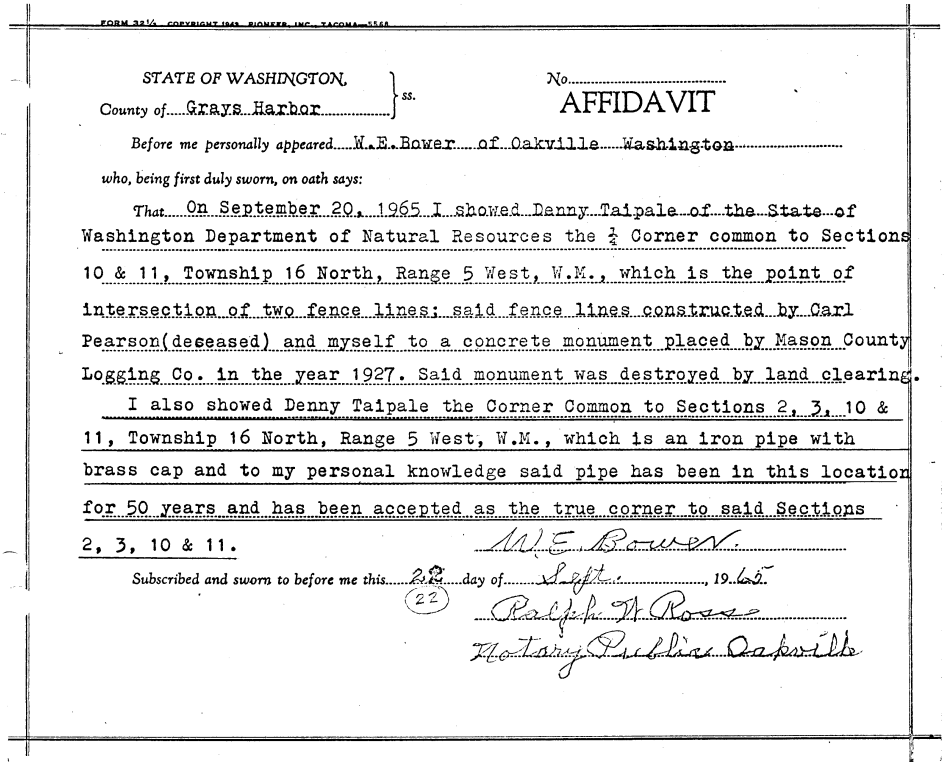
According to the BLM Manual of Surveying Instructions there are several ways, other than finding a monument or accessories (bearing trees), to determine the original location of a corner.

> *5-8. No decision should be made in regard to the restoration of a corner until every means has been exercised that might aid in identifying its true original position. The retracements will indicate the probable position and will show what discrepancies are to be expected. Any supplemental survey record or testimony should then be considered in the light of the facts thus developed.*

i. Use of Testimony in Restoring Corners

> *5-10. A corner is not considered as lost if its position can be recovered satisfactorily by means of the testimony and acts of witnesses having positive knowledge of the precise location of the original monument.*

This affidavit demonstrates a way to use testimony evidence.



FORM 32¼ COPYRIGHT 1943 PIONEER, INC., TACOMA—5568

STATE OF WASHINGTON, } ss.
County of Grays Harbor }

No.

AFFIDAVIT

Before me personally appeared W.E.Bower of Oakville Washington

who, being first duly sworn, on oath says:

That On September 20, 1965 I showed Danny Taipale of the State of Washington Department of Natural Resources the ½ Corner common to Sections 10 & 11, Township 16 North, Range 5 West, W.M., which is the point of intersection of two fence lines; said fence lines constructed by Carl Pearson(deceased) and myself to a concrete monument placed by Mason County Logging Co. in the year 1927. Said monument was destroyed by land clearing.

I also showed Denny Taipale the Corner Common to Sections 2, 3, 10 & 11, Township 16 North, Range 5 West, W.M., which is an iron pipe with brass cap and to my personal knowledge said pipe has been in this location for 50 years and has been accepted as the true corner to said Sections 2, 3, 10 & 11.

W.E. Bower

Subscribed and sworn to before me this 22 (22) day of Sept., 19 65

Ralph W. Rowe

Notary Public Oakville

Figure 43

ii. Topographic Calls as Evidence

BLM Manual 5-16

5-16. The proper use of topographic calls of the original field notes may assist in recovering the locus of the original survey. Such evidence may merely disprove other questionable features, or it may be a valuable guide to the immediate vicinity of a line or corner. At best, it may fix the position of a line or corner beyond reasonable doubt....

Misapplication usually may be avoided by applying the following tests:

(1) The determination should result in a definite locus within a small area.

(2) The evidence should not be susceptible of more than one reasonable interpretation.

(3) The corner locus should not be contradicted by evidence of a higher class or by other topographic notes.

Does the diagram below depict a Corner which could be restored from Topographic Calls?

Figure 44 below is a diagram of possible topographic calls from the field notes of GLO survey. The particular relationship of the calls (topographical references) to one another creates a situation in which there is significant uncertainty as to the location of a corner relative to creek and swamp measurements. The corner could move significantly in a northwest-southeast direction and still roughly match the called distances.

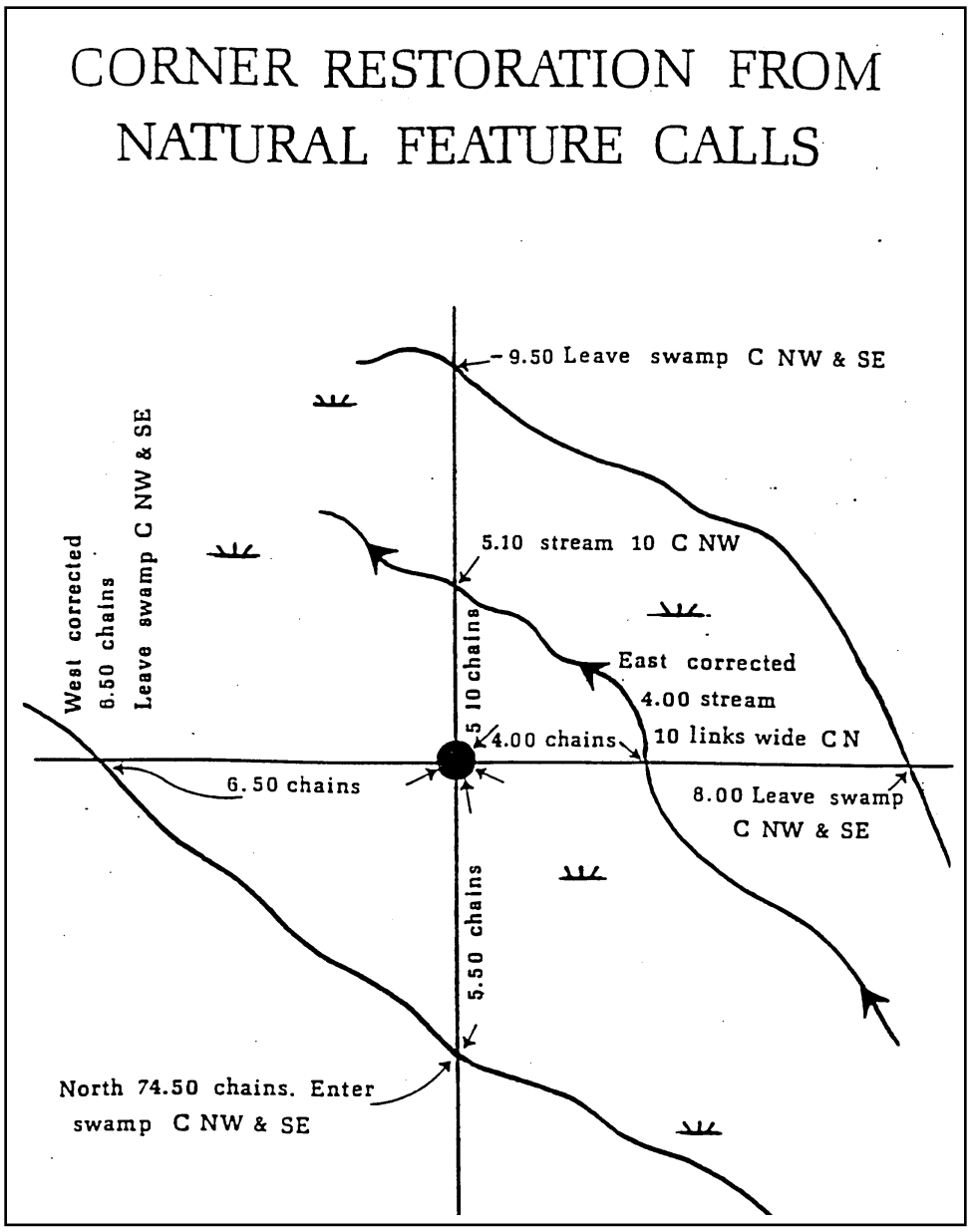

CORNER RESTORATION FROM NATURAL FEATURE CALLS
9.50 Leave swamp C NW & SE
West corrected
6.50 chains
Leave swamp C NW & SE
5.10 stream 10 C NW
5.10 chains
East corrected
4.00 stream
10 links wide C N
4.00 chains
6.50 chains
8.00 Leave swamp
C NW & SE
5.50 chains
North 74.50 chains. Enter
swamp C NW & SE

Figure 44

This corner was restored from topographic calls.
Would the double proportion position have been better?

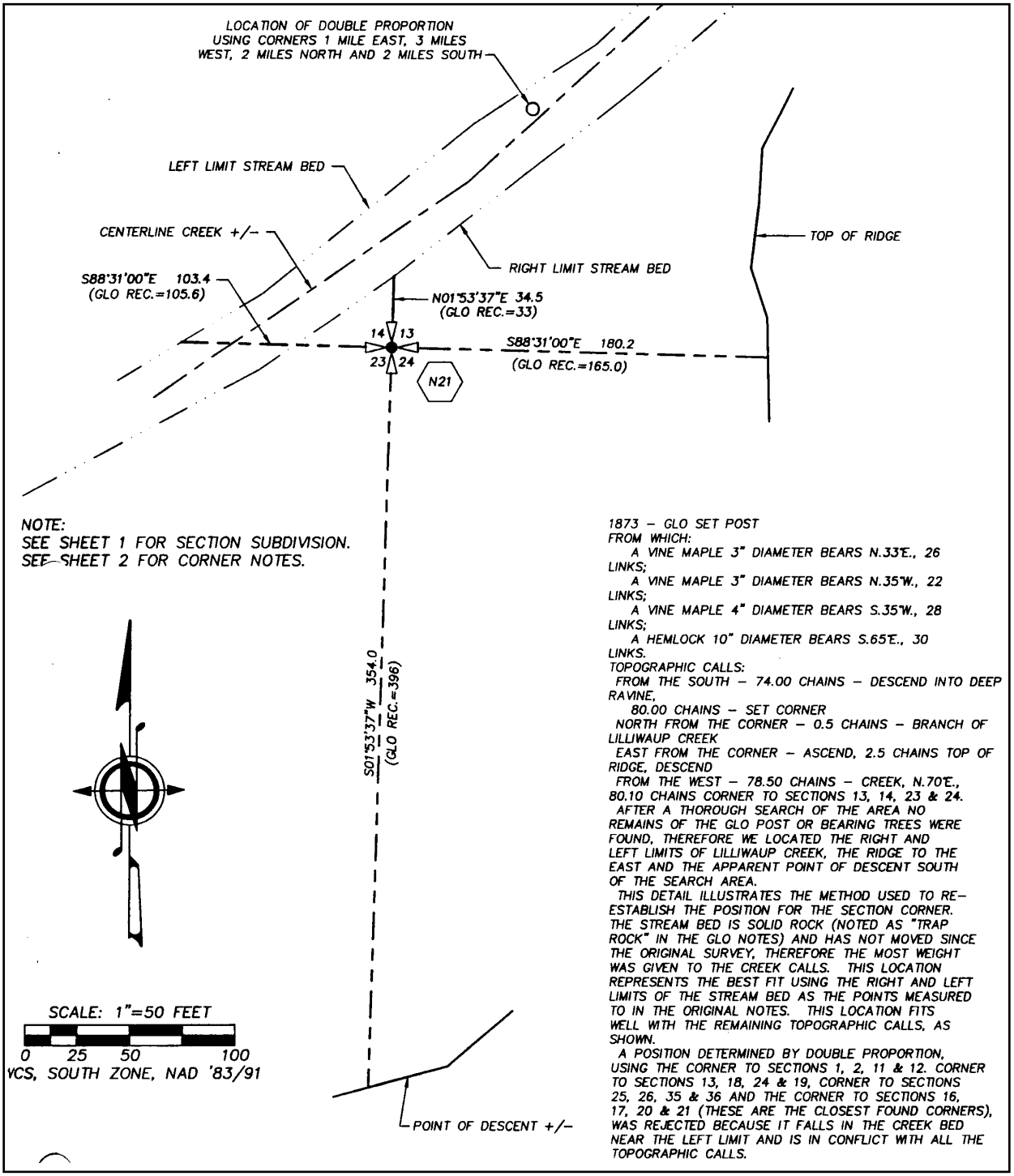


Figure 45

iii. Using Survey Records

Survey records, recorded and unrecorded, can often provide sufficient evidence as to the location of a corner so that proportioning need not be resorted to.

Section 16, T17N, R28E, W.M.

The northwest corner of section 16 falls within Potholes Reservoir. The position was restored using a US Bureau of Reclamation survey record. See the narrative, Figure 47 on page 67.

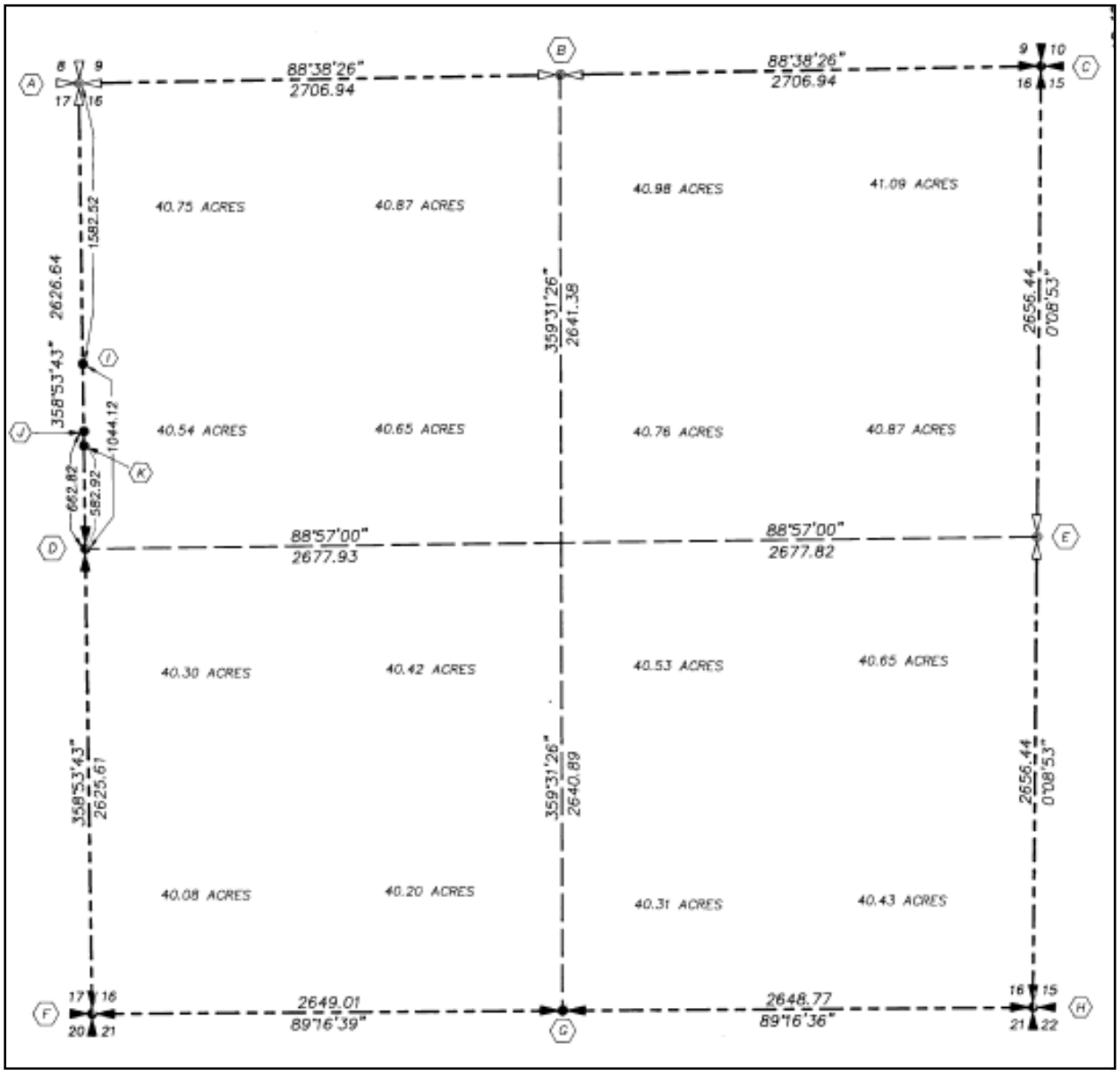


Figure 46

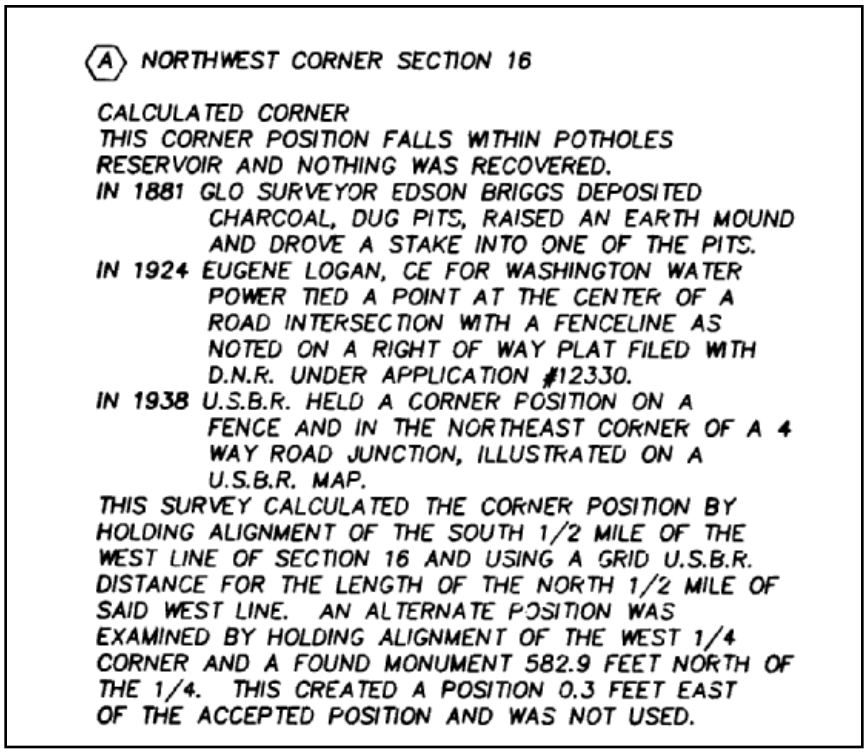

A NORTHWEST CORNER SECTION 16
CALCULATED CORNER
THIS CORNER POSITION FALLS WITHIN POTHOLES
RESERVOIR AND NOTHING WAS RECOVERED.
IN 1881 GLO SURVEYOR EDSON BRIGGS DEPOSITED
CHARCOAL, DUG PITS, RAISED AN EARTH MOUND
AND DROVE A STAKE INTO ONE OF THE PITS.
IN 1924 EUGENE LOGAN, CE FOR WASHINGTON WATER
POWER TIED A POINT AT THE CENTER OF A
ROAD INTERSECTION WITH A FENCELINE AS
NOTED ON A RIGHT OF WAY PLAT FILED WITH
D.N.R. UNDER APPLICATION #12330.
IN 1938 U.S.B.R. HELD A CORNER POSITION ON A
FENCE AND IN THE NORTHEAST CORNER OF A 4
WAY ROAD JUNCTION, ILLUSTRATED ON A
U.S.B.R. MAP.
THIS SURVEY CALCULATED THE CORNER POSITION BY
HOLDING ALIGNMENT OF THE SOUTH 1/2 MILE OF THE
WEST LINE OF SECTION 16 AND USING A GRID U.S.B.R.
DISTANCE FOR THE LENGTH OF THE NORTH 1/2 MILE OF
SAID WEST LINE. AN ALTERNATE POSITION WAS
EXAMINED BY HOLDING ALIGNMENT OF THE WEST 1/4
CORNER AND A FOUND MONUMENT 582.9 FEET NORTH OF
THE 1/4. THIS CREATED A POSITION 0.3 FEET EAST
OF THE ACCEPTED POSITION AND WAS NOT USED.

Figure 47

Section 35, T33N, R5E, W.M.

The northwest corner and north quarter corner of section 35 were lost. See Figure 48 below. A 1911 county surveyor's record shows found corners that are far distant from double and single proportioned positions. The county surveyor's record was used to re-establish the corners. See the narrative, Figure 49 on page 69.

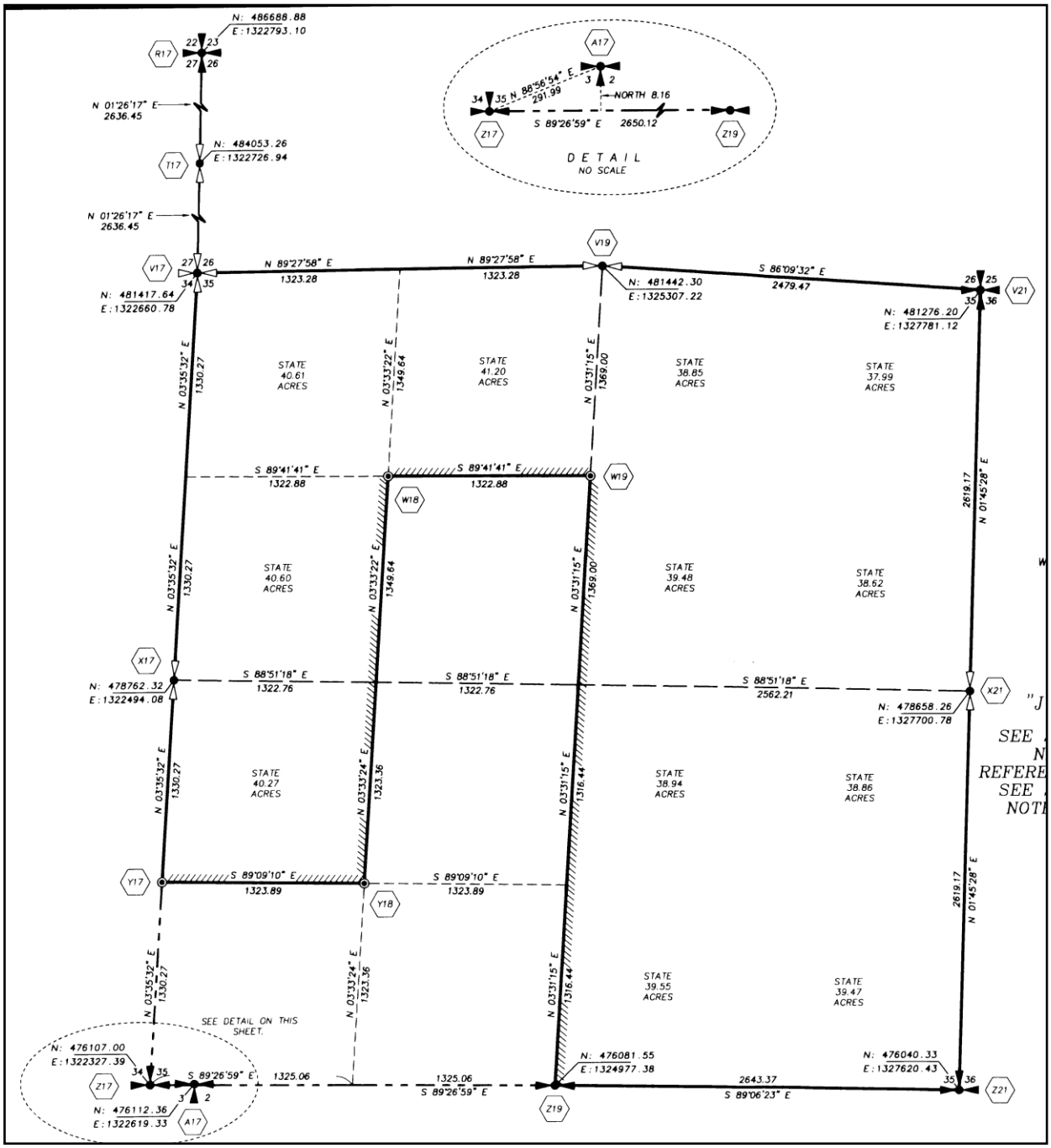


Figure 48

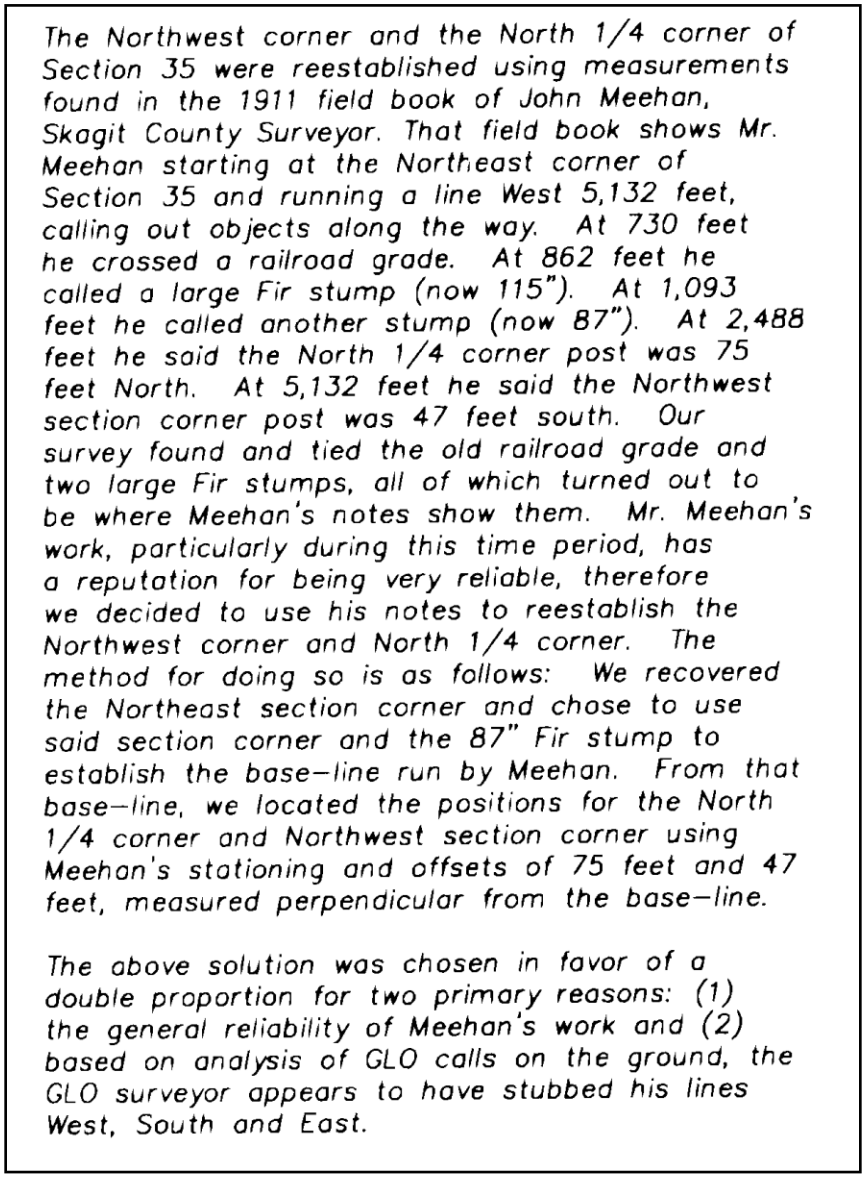

The Northwest corner and the North 1/4 corner of Section 35 were reestablished using measurements found in the 1911 field book of John Meehan, Skagit County Surveyor. That field book shows Mr. Meehan starting at the Northeast corner of Section 35 and running a line West 5,132 feet, calling out objects along the way. At 730 feet he crossed a railroad grade. At 862 feet he called a large Fir stump (now 115"). At 1,093 feet he called another stump (now 87"). At 2,488 feet he said the North 1/4 corner post was 75 feet North. At 5,132 feet he said the Northwest section corner post was 47 feet south. Our survey found and tied the old railroad grade and two large Fir stumps, all of which turned out to be where Meehan's notes show them. Mr. Meehan's work, particularly during this time period, has a reputation for being very reliable, therefore we decided to use his notes to reestablish the Northwest corner and North 1/4 corner. The method for doing so is as follows: We recovered the Northeast section corner and chose to use said section corner and the 87" Fir stump to establish the base-line run by Meehan. From that base-line, we located the positions for the North 1/4 corner and Northwest section corner using Meehan's stationing and offsets of 75 feet and 47 feet, measured perpendicular from the base-line.
The above solution was chosen in favor of a double proportion for two primary reasons: (1) the general reliability of Meehan's work and (2) based on analysis of GLO calls on the ground, the GLO surveyor appears to have stubbed his lines West, South and East.

Figure 49

6. Double Proportion Made Complex

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ABSTRACT

Our ever increasing ability to accurately measure makes it more critical that we understand the geodetic and legal concepts behind some common survey principals. As presented here, the process of determining the position of a lost section corner under the Public Land Survey rules is well known, and is even generally a matter of actual statute law. On the technical side this paper will discuss how an awareness of the unusual characteristics of the *'Public Land Survey System Datum'* and the historical *'Manual'* procedures lead to some interesting conclusions about the proper way to compute double proportion positions for lost corners. This discussion will include examples of how both large and small errors can creep into the process when using coordinates, especially State Plane Coordinates, and point out dangerous situations as well as proper methods to use to avoid pitfalls.

GENERAL

This presentation deals with one of those seemingly insignificant technical issues that may rise up and bite you if you are not careful. This particular discussion relates to the procedure used to restore certain lost corners in Public Land Surveys by the process called double proportion. This is a well known procedure to surveyors in such public land states who practice in suburban or rural areas. It is a process that seems straightforward on the surface, but is also sometimes misunderstood and incorrectly computed.

In defense of this *technical* presentation, I would like to point out that in my opinion there are many aspects to the profession of surveying. Some of the aspects on which we place the highest importance are the evaluation of evidence, discovery and analysis of prior records and application of judgment. These and other professional issues are well recognized and are significant issues in licensure. Somewhere on the list of attributes that constitute the makeup of the profession of surveying is technical expertise and knowledge of proper procedures in measurement and computation. By no means are these considerations primary, but neither are they insignificant. This discussion is almost entirely technical and one sided. Whereas in the real world I recognize that many other factors control our actions and considerations.

Before I can illustrate some of the technical quirks of double proportion, I need to briefly describe something that I refer to as 'The PLSS Datum'. This datum is simple but has some unique and even strange attributes. A thorough description of it and all its consequences could easily be the topic of several papers, so what is outlined here is necessarily brief.

THE PLSS DATUM

The 'PLSS Datum' is the reference system by which the majority of the PLSS surveys are

theoretically reported. The data being reported on a BLM or GLO Cadastral Survey plat are, of course, bearings and distances. But bearings and distances with reference to what? The current BLM Manual of Surveying Instructions, 1973 states:

"2-1. The law prescribes the chain as the unit of linear measure for the survey of the public lands. All returns of measurements in the rectangular system are made in the true horizontal distance in miles, chains and links...."

"2-17. The direction of each line of the public land surveys is determined with reference to the true meridian as defined by the axis of the earth's rotation. Bearings are stated in terms of angular measure referred to the true north or south."

"2-74. .... By basic law and the Manual requirements, the directions of all lines are stated in terms of angular measure referred to the true north (or south) at the point of record."

Distances. These and other references in the BLM and GLO Manuals make it clear that the frame of reference for *distances* is defined as horizontal measure in chains based on the U.S. Survey Foot at actual ground elevation. This is of importance when performing computations in projections or at sea-level when the actual lines are at a significant elevation. If you are computing proportions in a projection, the variation of elevation over a project can have a small effect, the elevation difference in essence weights the record ground measurements. This usually is a small effect unless the lines differ in elevation by a 1000 ft. or so.

Bearings: The above Manual sections and others identify the frame of reference for *direction* as something called 'Mean True Bearings' referenced to the true astronomic meridian '..at the point of record.' For those of you familiar with basic geodesy you will recognize that this is a basis of bearing that changes as you go east and west since the reference meridians are not parallel but converge towards the pole.

Because this is a changing reference, the direction of a straight line on the ground can be described with a forward bearing based on the meridian at the beginning end, or with a differing back bearing based on the meridian at the end point. The difference between them is the angle of convergence of the two meridians. If we want to accurately describe how far north or west the line goes in a geodetic sense, we need to use the average or 'mean' of these two values. This *'mean bearing'* is essentially identical to the bearing of the traverse line with reference to its midpoint. Thus the 'point of record' for determining the bearing of a straight traverse line can be said to be the meridian at the midpoint of the line.

Straight Lines: Therefore, one unusual byproduct of the PLSS datum is that:

Straight lines on the ground are lines of constantly changing bearing.

A straight line is basically what you would lay out by double centering or projecting a direct line of sight. The only straight line that does have a constant bearing is the meridian or north and south line. An example of a boundary that might be a straight line is one that is described as a straight line running from one physical monument to another. Such a line, if reported in the PLSS Datum would have different forward and back bearings, and different bearings at each point along it.

Rhumb Lines: It is also apparent from the various GLO and BLM Survey Manuals and the actual methods that were used to lay out the public land surveys that most boundary lines in the PLSS are intended not to be straight lines but lines of constant bearing or Rhumb Lines. Such lines cross every meridian at the same angle and are thus curved as viewed on the ground.

Therefore, another unusual byproduct of the 'PLSS datum' is that:

Lines of constant bearing are curved lines on the ground.

For example, the solar compass and transit were instruments that determined bearing at each setup, and when matched with traditional chaining, measured or laid out lines of constant bearing.

The *'Manual'* discussion of latitudinal arcs illustrates one example of a rhumb line. A parallel of latitude is a line that is due East and West in the PLSS Datum. Since it crosses each meridian at a 90 degree angle, it has a mean bearing of East or West. Lines of constant bearing in the PLSS datum will appear curved on the ground. It also turns out that the mean bearing of any chord or sub-chord connecting any two points along such a line is the same as the bearing of the rhumb line itself. Thus it is possible to lay out points on a rhumb line by correcting traverse lines to their mean bearing in computations.

DOUBLE PROPORTION

Now let's look at the definition of double proportion as stated in the BLM *Manual of Surveying Instructions, 1973*, which states:

"5-25. The term 'double proportionate measurement' is applied to a new measurement made between four known corners, two each on intersecting meridional and latitudinal lines, for the purpose of relating the intersection to both.

In effect, by double proportionate measurement the record directions are disregarded, excepting only where there is some acceptable supplemental survey record, some physical evidence, or testimony that may be brought into the control. Corners to the north and south control any intermediate latitudinal position. Corners to the east and west control the position in longitude."

.....

"Lengths of proportioned lines are comparable only when reduced to their cardinal equivalents."

Cardinal Equivalents: The last sentence in the above quote is one that requires some explanation. What it means is that only the easterly components (or departures) of the E-W controlling record lines are used to compute the E and W position, and only the northerly components (or latitudes) of the N-S controlling record lines are used to compute the N and S position. This is different than using the line lengths or distances on the record line.

Figure 2 illustrates the cardinal equivalents for some of the lines in the example record shown in Figure 1. Neglecting to correct the record for cardinal equivalents won't usually get you in

trouble since most section lines in the original surveys are very near to cardinal and the correction is insignificant. There are, however, many situations in public land surveys where this is not the case. This situation will also occur where a retracement or subsequent GLO or BLM resurvey has reported new measurements in the PLSS datum, and the lines are distorted. The record shown in Figure 1 is a typical example, and is used to illustrate the problem.

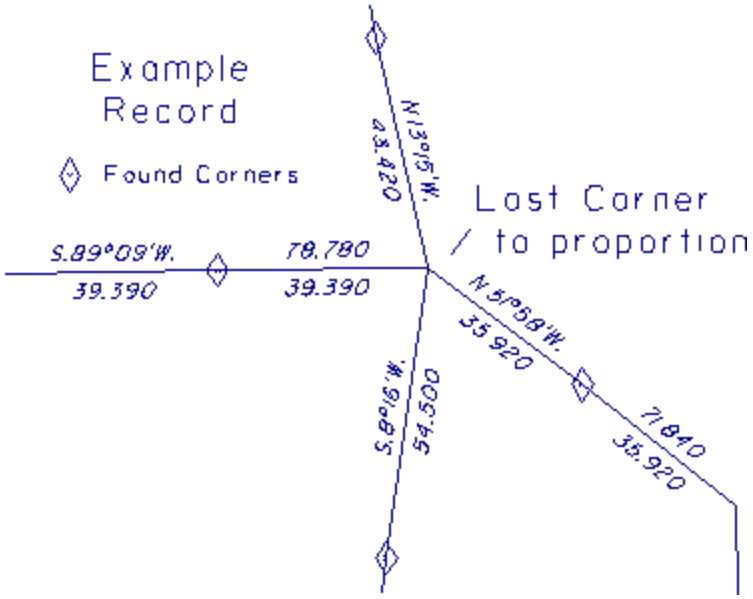

Figure 1 **- Example Record**

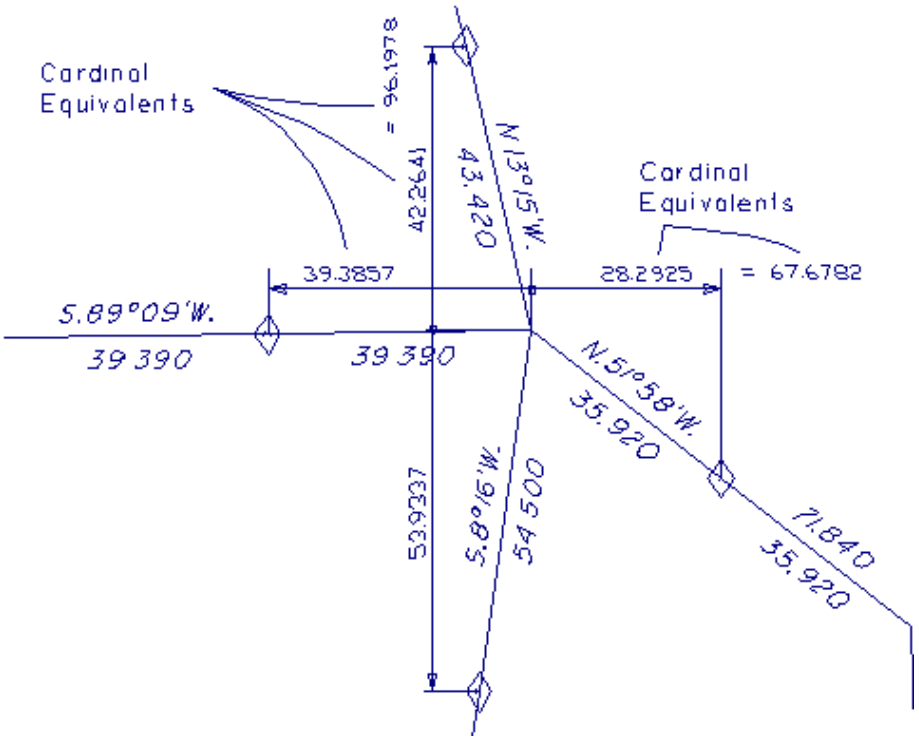

Figure 2 **- Cardinal Equivalents**

Cardinal offsets

The Manual of Surveying Instructions, 1973 Section 5-26 describes a process for performing a double proportion. The Manual section states:

"5-26. In order to restore a lost corner of four townships, a retracement will first be made between the nearest known corners on the meridional line, north and south of the missing corner, and upon that line a temporary stake will be placed at the proper proportionate distance; this will determine the latitude of the lost corner.

"Next, the nearest corners on the latitudinal line will be connected, and a second point will be marked for the proportionate measurement east and west; this point will determine the position of the lost corner in departure (or longitude).

"Then, through the first temporary stake run a line east or west, and through the second temporary stake a line north or south, as relative situations may determine; the intersection of these two lines will fix the position for the restored corner."

Such a process would probably be impractical in the field if followed to the letter. It is, however, a valuable way to conceptualize a proper solution of a double proportion and a good way to model a computational method.

In brief, the three part process as described consists of:

A single proportion using the record E-W cardinal equivalents between the control E and W. In the Figure 3 example this would be point 'A'.

A single proportion using the record N-S cardinal equivalents between the control N and S. In the Figure 3 example this would be point 'B'.
Cardinal (true mean) offsets to intersection from those two points. In the Figure this results in point 'C'.

This last requirement can be a problem if you are not careful using coordinates, since to make the offsets cardinal requires knowledge of and proper correction to true north at those points. The common process of using the East coordinate of the E-W proportion and the North coordinate of the N-S proportion is equivalent to making a GRID offset, exaggerated In Figure 3 as point 'D', which can be incorrect.

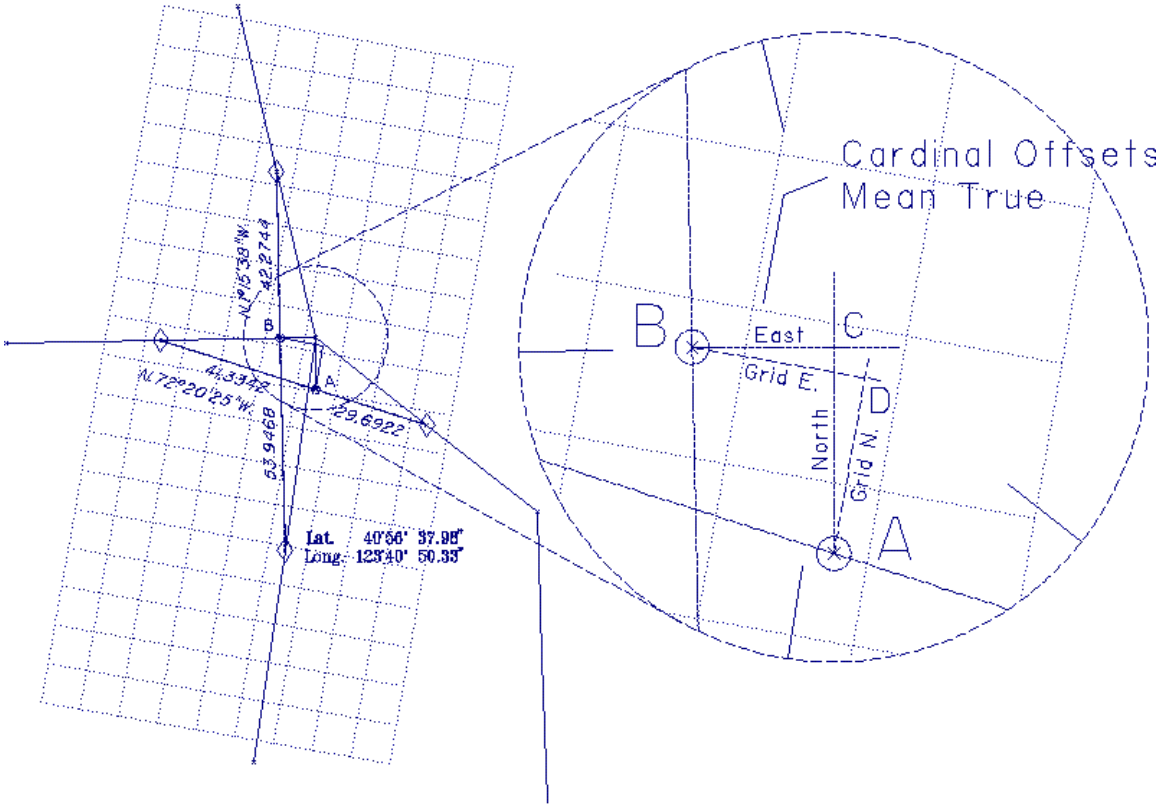

Figure 3 - Cardinal Offsets True vs. Grid

Problems with State Planes.

In using state plane coordinates there are several small problems, however dealing with cardinal offsets is the most critical. This is true because with State Planes there can be a large difference between grid and true north, which is called the mapping angle. There are three methods that can be used to correct for cardinal offsets using State Plane coordinates, they are:

- Compute the mapping angle at point A to find what grid azimuth equals true North, then compute the mapping angle midway between A and B to find what grid azimuth equals mean East, them compute a grid bearing intersect. If the offsets are not large, one

computation of mapping angle in the area will be adequate.

- Convert the coordinates to latitudes and longitudes at points A and B, use the latitude of B and the longitude of A and convert back to State Plane. This method essentially makes a geodetic cardinal offset.
- Convert the coordinates of the control corners to latitudes and longitudes and proportion them in a similar way to the above.

Small errors can still exist in the computation due to the datum differences. In State Planes the grid scale factor varies over the project. If you wanted to be perfect, this would require you to weight the proportions according to the mean scale factor over each line. This effect is very small. The last method is the easiest, since no correction for scale factor enters into the problem. However, performing proportions using geodetic coordinates directly can still have error if the lines are at very different elevations, since the PLSS datum represents measurements at actual average ground elevation over the line.

In the example problem, the error caused by direct proportion of the State Plane Coordinates is in excess of 20 ft. If you used a local grid or basis of bearings the following table illustrates corresponding errors for this example.

Grid Angle	Error D to C	
1° 05' 20"	20.11 ft.	California Zone I
0° 10'	3.40 ft.	Assumed 10' off true.
0° 01'	0.65 ft.	Assumed 01' off true.
0° 00' 45"	0.46 ft.	Basis of Bearing, Solar 1 mile E.

SUMMARY

It can be shown that in an ideal world and with a recognition of the properties of the *PLSS Datum*, the only way to properly restore a corner in its true original position is by diligent application of the *Manual* procedures, correcting record to cardinal equivalents, proportioning and making true cardinal offsets.

7. The Case Against Restoring Corners from Topographic Calls

From "General Instructions" issued by the Surveyor General of Wisconsin and Iowa in 1851:

Page 10 - "Your chain carriers must be reversed at every tally, so that one may be ahead upon the odd sad the other upon all the even tallies The discrepancies of measure likely to arise from unequal strength or care in chairmen, are thus rendered compensative; a check is instituted upon the accuracy of the tally, and the labor of recollecting and reporting objects is divided. As the chain men pass each other, the pins must be, in every instance, counted by each of them." (Emphasis added)

From "General Instructions to Deputy Surveyors" issued by the Surveyor General of Ohio, Indiana, and Michigan in 1850:

Page 17 - "3. In measuring lines, every-five chains are called a 'tally,' because at that distance the last of the ten tally pins with which the forward chairman set out, bas been set. He then cries 'tally,' which cry is repeated by the other chairman, and each registers the distance, by slipping a thimble, on a belt worn for that purpose, or by some other convenient method. The back chainman then comes up, and having counted, in the presence of his fellow, the tally pins which he has taken up, so that both may be assured that none of the pins have been lost, takes the forward end of the chain, and proceeds to set them. Thus the chainmen alternately change places, each setting the pins that he has taken up, so that one is forward in all the odd and the other in all the even tallies, which contributes to the accuracy of the measurement, facilitates the recollection of the distances to notable objects on the line, and renders a mistally almost impossible." (Emphasis added)
The instructions for chaining in the 1850 "General Instructions to Deputy Surveyors," issued by the Surveyor General of Ohio, Indiana, and Michigan are the earliest we have that use the particular phrasing about "recollection". With only minor modifications, this paragraph appears in all manuals issued by the Commissioner until the 1902 manual, which. discontinued it:

1851 Oregon manual	Page	8
1855 manual	"	3
1871 "	"	8 and 9
1881 "	"	20
1890 "	"	19 and 20
1894 "	"	20 and 21

NOTATION OF TOPOGRAPHICAL CALLS ABOUT THE TURN OF THE CENTURY

Thomas A. Tillman
March 17, 1972

I worked as a field assistant on General Land Office survey parties in Oregon during six field seasons from 1936 through 1941. The chief of party for whom I worked in all of those seasons was George F. Rigby, who was in his fifties when I was first hired. Mr. Rigby retired about 1945. He returned briefly to assist in developing the Missouri Basin survey program. From 1948 into the fifties I again spent a lot of time in Mr. Rigby's company. Although retired, he came to the office daily to copy the field notes of surveys for the public and for county surveyors.

During the office season, usually four or five months a year in winter, he made one of a group of surveyors - Norman D. Price; Otis 0. Could, Marvin T. Lytle, Theodore VanderMeer, and myself - who always lunched together. The conversation usually dealt with surveying and surveying problems. Throughout the years, in tent camps, around campfires, and over lunch in the field and office, I listened to many reminiscences by Mr. Rigby. I heard him tell the following anecdote half a dozen times.

Rigby began as a survey assistant with his brother-in-law sometime about the turn of the century. Afterward, he went to work for another contract surveyor. While chaining for his brother-in-law, he had carried a small composition-type notebook in his hip pocket and noted down topographic items. On his new job he continued the practice. At the end of the first day the deputy surveyor called the chainmen to his tent and asked for the day's field notes. The other chainman stood and recited the topography from memory for the entire day. The survey was in the Dakotas where the surveys covered a big mileage each day. Nevertheless, Rigby said that the chainman's recollection was not bad. After he had finished reciting, the surveyor asked Rigby it he agreed with the calls. Rigby pulled cut his notebook and commenced reading. The surveyor was amazed. He told Rigby that in all his years of surveying this was the first time a chainman of his had made written notes of the topography.

This must have been before, or not long after, the issuance of the 1902 surveying manual. The "process of chaining" described in all previous manuals (1855 to 1894) was stated in the text to be a help in the recollection of the distance to object= on line. I doubt if Mr. Rigby knew of this reference in the old manuals until later. When I spoke disparagingly of such a way of raking notes, Rigby said that many of the survey assistants in that era could not read or write. He thought this might account for the practice.

REMINISCENCES OF WILLIAM. R. BANDY

Helena, Montana
May 25, 1972

From June 1st 1905 to July 1906 I worked as a field assistant for Samuel W. Brunt and Arthur H. Brunt contract surveyors for the U. S. General Land Office. For

the first month I was cornerman, marking and setting stone corner monuments in the Big Horn Basin, in northern Wyoming. I was working under W. W. Utterback.
Starting July 1st 1905, I was chainman for the same outfit under a Mr. Gratzenberg, transitman for the Brunts. While chaining I was teamed up with Arthur W. Brunt. I was the leadoff man having the odd numbered tallies. With reference to the manner of reporting the items of topography encountered along the section lines, I will say we chairmen had no note books in 1905 and 1906. We kept track of the distances by our pins, sticking one pin for every full chain reached. On steep hillsides where we could not level a whole chain we would make a mark and say mark 25, or whatever it was, and leave a pin when 100 links was reached. All distances were true horizontal distances. Distances to line trees or other definite points along the lines were accurately measured to the nearest link, and reported to the transitman who kept a detailed record. Both chairmen paid particular attention to distances, and checked with each other when reporting to the transitmen from time to time. We fully realized the accuracy of the map to be made from our record depended upon us, to that extent. We made it a point to report intermediate distances at the first opportunity. The party chiefs prepared their sketch plats of evenings, Sundays and rainy days. If a creek crossing appeared to be missing, the chairmen would be called upon to try to supply the missing data from memory. I would not recommend restoring missing corners from items mentioned in the chainmen's notes except in special instances.
As a transitman in 1906 and 1907, or I should say as a U. S. Deputy Surveyor, I made notations in my field note book as I walked the section lines, of streams, ridges, fences or other items of topography and filled in the distances when the chainman found time to report. It they had missed something, we filled it in the best we could, while fresh in our memory and on the ground.

EXCERPT FROM DRAFT OF 1972 MANUAL

10

5-15. A line tree or a definite connection to readily identified natural objects or improvements may fix a point or the original survey in latitude or departure in the absence of an original monument. The mean position of a blazed line, when identified as the original line, may help to fix a meridional line for departure, or a latitudinal line for latitude. Such blazed lines must be carefully checked, because corrections may have been made before final acceptance of the old survey or more than one line may have been blazed.

5-16. The proper use of topographic calls of the original field notes may assist in recovering the locus of the original survey. Such evidence may merely disprove other questionable features, or it may be a valuable guide to the immediate vicinity of a line or corner. At best, it may fix the position of a line or corner beyond reasonable doubt.

Allowance should be made for ordinary discrepancies in the calls relating

to items of topography. Such evidence should be considered more particularly in the aggregate; when it is round to be corroborative, an average may be secured to control the final adjustment. This will be governed largely by the evidences nearest the particular corner in question, giving the greatest weight to those features that agree most closely with the record, and to such items as afford definite connection..

11

A careful analysis should be made by the surveyor before using topographic calls to fix an original corner point. Indiscriminate use will lead to problems and disputes where two or more interpretations are possible. Close attention should be given to the manner in which the original survey was made. Instructions for chaining in the earlier manuals indicate that memory was an important factor in recording distances to items of topography. Early field notes often appear to have shown distances only to the nearest chain or even a wider approximation.

In comparing distances returned in the original field notes with those returned in the resurveys, gross differences appear in a significant number of instances. In some cases the original surveyor apparently surveyed a line in one direction, but then reversed the direction in his record without making corresponding changes in distances to items of topography. These facts have sometimes caused distrust and virtual avoidance of the use of topography in corner restoration where proper application might be extremely helpful. Misapplication usually , may be avoided by applying the following tests:

(1) The determination should result in a definite locus within a small area.
(2) The evidence should not be susceptible of more than one reasonable interpretation.
(3) The corner locus should not be contradicted by evidence of a higher class or by other topographic notes.

12

The determination of the original corner point from even fragmentary evidence of the original accessories, generally substantiated by the original topographic calls, is much stronger than determination from topographic calls alone. In questionable cases it is better practice, in the absence of other collateral evidence, to turn to the suitable means of proportionate measurement.

III. Section Subdivision

1. Introduction to Section Subdivision

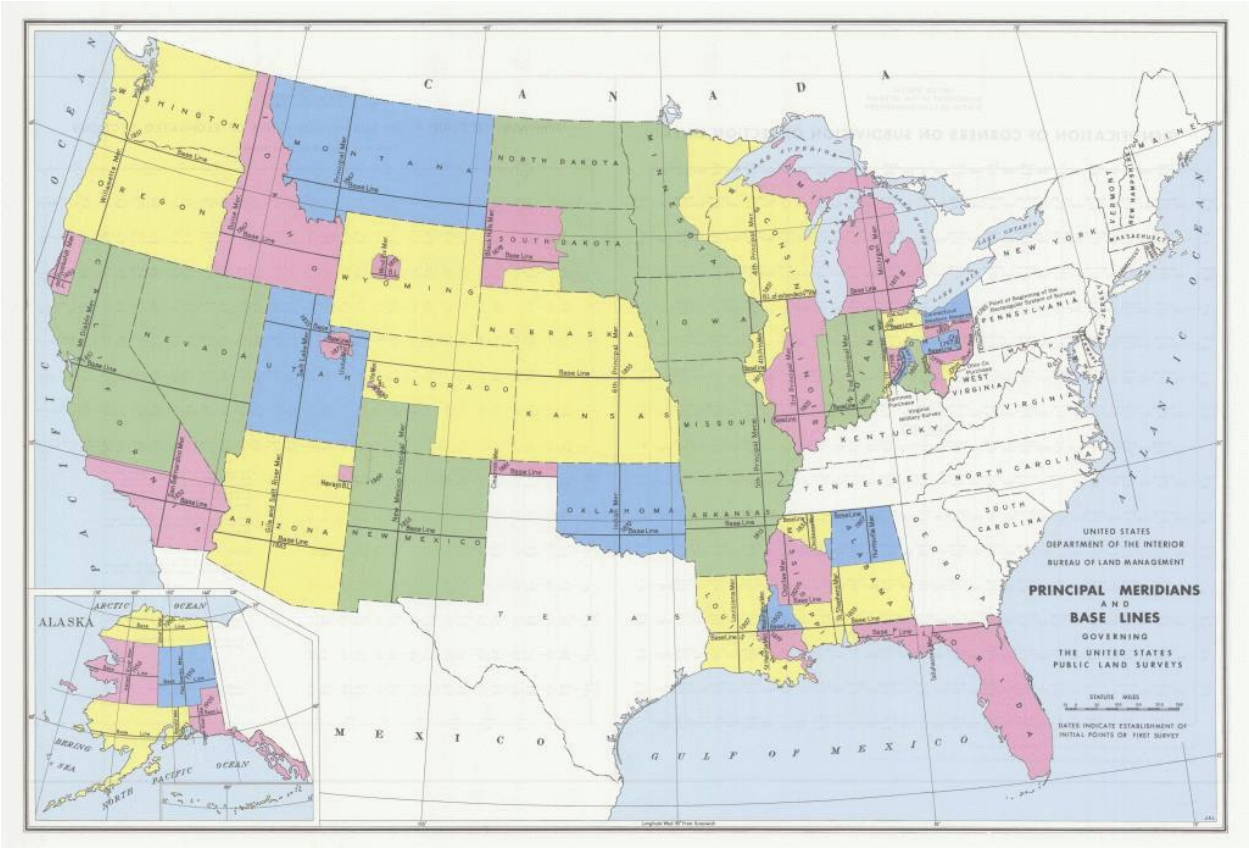

Figure 50

i. The Function of the Local Surveyor

The 1973 Manual summarizes the function of the local surveyor and gives some guidelines for performance.

3-76. The local land surveyor is employed as an expert to identify lands which have passed into private ownership .....
In this capacity the local surveyor is performing a function contemplated by law. He cannot properly serve his client or the public unless he is familiar with the legal requirements concerning subdivision of sections .....

3-92. By way of recapitulation it is emphasized that when entrymen have acquired title to certain legal subdivisions they have become the owners of the identical ground area

represented by the same subdivisions upon the official plat. It is a matter of expert or technical procedure to mark out the legal subdivisions called for in a patent, and entrymen are advised that a competent surveyor should be employed. The surveyor must identify the section boundaries and locate the legal center of the section in order to determine the boundaries of a quarter section. Then, if the boundaries of quarter-quarter sections, or fractional lots, are to be determined on the ground, the boundaries of the quarter section must be measured, and the sixteenth-section corners fixed in accordance with the proportional distances represented upon the approved plat. Finally, the legal center of the quarter section may be duly located. Thus will be produced in the field the figure represented upon the plat, every part of the former in true proportion to the latter, where the elements of absolute distance and area have given way to corresponding proportional units as defined by fixed monuments established in the original survey.

3-85. ... Some cases arise, however, which are not covered by these rules and require the advice of the Bureau of Land Management. The letter of inquiry should contain a description of the particular tract or corner, with reference to township, range, and section of the public surveys, together with a diagram showing conditions found.

Federal Accuracy Requirements for a Legal Survey

United States Code, Title 43, Chapter 18

The United States Code, Title 43, Chapter 18, gives some advice for the local surveyor to remember. The essential idea of the law is that surveying is a practical endeavor in which corners can be established permanently in a position that is good enough for the purpose, to have definite and settled boundaries.

§ 752. Boundaries and contents of public lands; how ascertained

*... and the corners of half and quarter sections, not marked on the surveys, shall be placed **as nearly as possible** equidistant from two corners which stand on the same line.*

§ 753. Lines of division of half quarter sections; how run

*... on the principles directed and prescribed by section 752 of this title ... shall in like manner **as nearly as practicable** be subdivided into half and quarter-sections ... shall in like manner, **as nearly as practicable**, be subdivided into quarter quarter-sections*

ii. Corner Designations

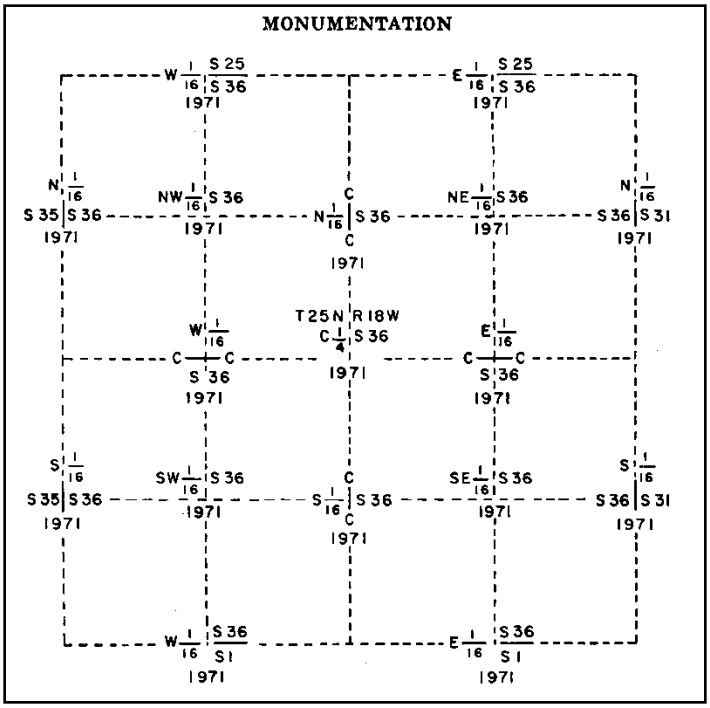

Figure 51

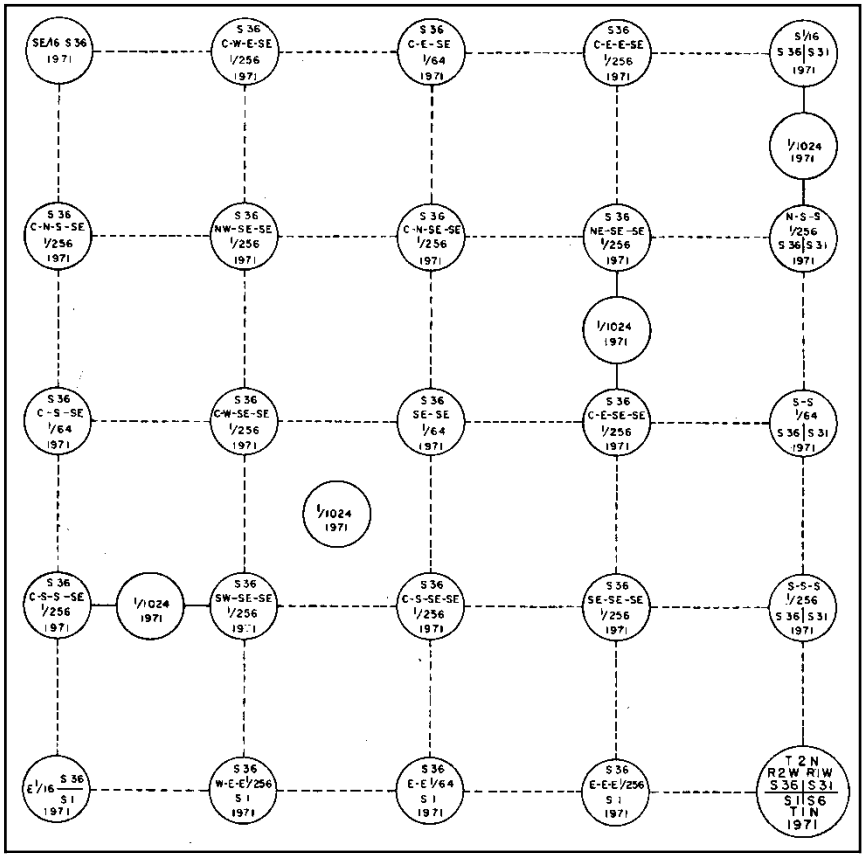

Figure 52

iii. The basic rules for subdividing a section into 1/16 sections

1. The center 1/4 corner is at the intersection of the lines connecting opposite 1/4 corners.
2. When no opposite 1/4 corner can be fixed, survey on a mean or parallel bearing.
3. A 1/16 corner is:
    a. At the midpoint between controlling corners when there are no government lots involved.
    b. At a proportioned distance between controlling corners when there are government lots involved.
    c. At a proportioned distance when a controlling corner is not a 1/4 or section corner, for example a meander corner or a line tree.
4. The center of a quarter section is at the intersection of lines connecting opposite 1/16 corners.
5. When no opposite 1/16 corner can be fixed, survey on a mean or parallel bearing.

2. Theoretical Section Subdivision and Found Survey Monuments

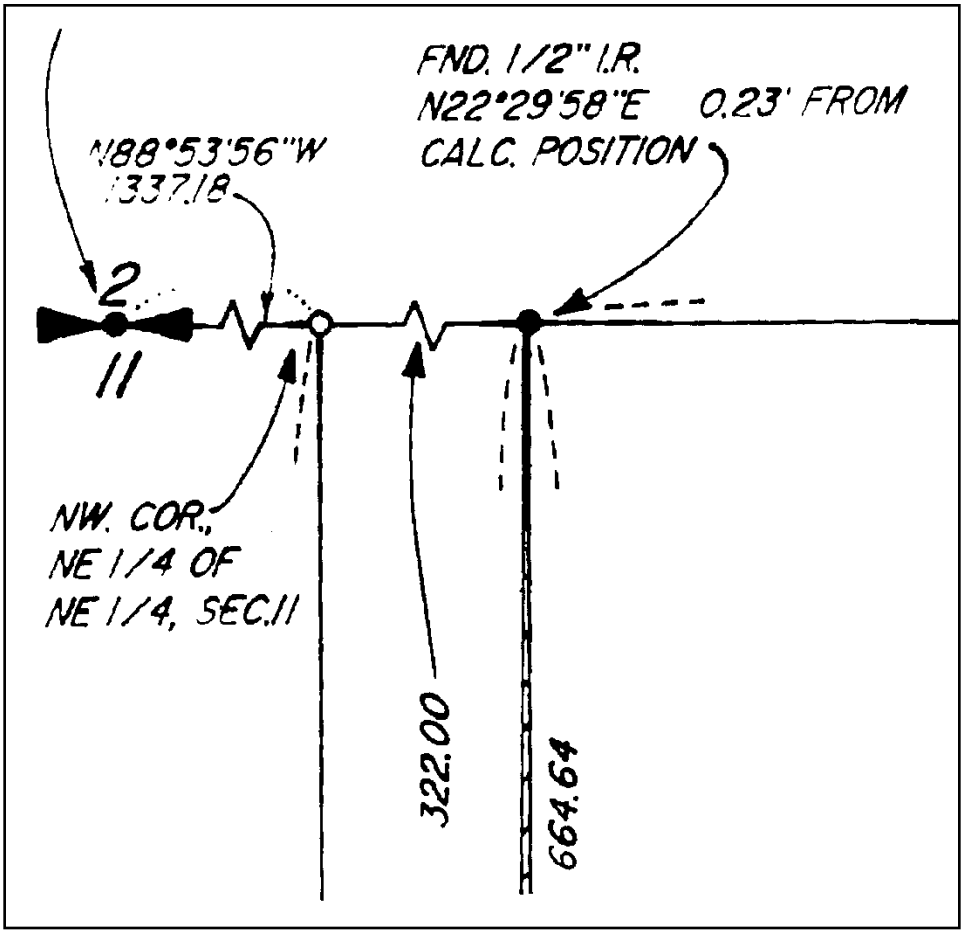

Figure 53

i. Corners and Monuments Definitions

The 1973 BLM Manual of Surveying Instructions, section 5-4, defines corners and monuments as follows:

> *The terms "corner" and "monument" are not interchangeable. A "corner" is a point determined by the surveying process. A "monument" is the object or the physical structure which marks the corner point.*

Merriam-Webster's Third International dictionary, on the other hand, allows the word corner to have a physical definition: "*a stake, tree, or other mark designating the point of intersection of two boundary lines of a piece of land*." However, Webster's first definition of the word is "*the point or place where two converging lines, edges, or sides meet*." Webster recognizes the common sense understanding that the word corner has both an abstract meaning of a place and a concrete meaning of an object marking a place. Webster's definition of monument, as "*a natural or artificial but permanent object serving to indicate a limit or to mark a boundary*," limits the use of the term to physical objects, as does the BLM definition.

The words corner and monument are used in defining the authority of surveyors at both the federal and local level. When the words are used in BLM manuals and instructions, the definitions in the BLM Manual should be used. When the words are used in state law, the broader dictionary definition of the word corner, where it can mean either a place or a monument, should be considered as the most probable definition.

ii. Significance of Federal Authorized Corners

The corners established by a federal survey under the Department of Interior or its predecessor, the General Land Office, have a high legal status. They constitute the basis for locating the disposals of public lands.

U.S. Code Title 43, Chapter 18, § 752:

> *All the corners marked in the surveys, returned by the Secretary of the Interior or such agency as he may designate, shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate;*

iii. Significance of State Authorized Corners

United States law recognizes that the federal surveys need to be supplemented by surveys conducted locally, under state authority, and gives those surveys legal recognition.

U.S. Code Title 43, Chapter 18, § 766:

> *and all subdividing of surveyed lands into lots less than one hundred and sixty acres may be done by county and local surveyors at the expense of claimants;*

The State of Washington has established a land surveyor registration system through which certain individuals are recognized by the state as having authority to survey land and establish corners.

The Revised Code of Washington, 18.43.020, first defines a land surveyor and then defines the practice of land surveying.

> *(6) "Land surveyor" means a professional land surveyor.*
> *(7) "Professional land surveyor" means a person who, by reason of his or her special knowledge of the mathematical and physical sciences and principles and practices of land surveying, which is acquired by professional education and practical experience, is qualified to practice land surveying and as attested to by his or her legal registration as a professional land surveyor.*
> *(9) "Practice of land surveying" means assuming responsible charge of the surveying of land for the establishment of corners, lines, boundaries, and monuments, the laying out and subdivision of land, the defining and locating of corners, lines, boundaries, and monuments of land after they have been established, the survey of land areas for the purpose of determining the topography thereof, the making of topographical delineations and the preparing of maps and accurate records thereof, when the proper performance of such services requires technical knowledge and skill.*

Washington law gives persons with state registration as a professional land surveyor the authority of "*surveying of land for the establishment of corners, lines, boundaries, and monuments*." Notice the use of the term *"establishment*." Washington surveyors can establish original corners and monuments for those corners. Also, original corners are established by local surveyors when they subdivide sections.

Washington law also gives registered surveyors the authority to resurvey previously established corners and lines with the words authorizing "*the defining and locating of corners, lines, boundaries, and monuments of land after they have been established*."

In short, Washington law gives registered land surveyors the authority to conduct both original and retracement surveys.

iv. Acceptance and Rejection of Found Survey Monuments

The question whether to accept or to reject found monuments has been troublesome for land surveyors. Here the discussion is confined to those found monuments known to have been established by an authorized survey. There is almost universal recognition among surveyors of the authority of federally established original corners. The authority of locally established original corners, however, and the authority of local retracements of previous surveys are not so clear. There are several categories of such corners.

a. Original corners set by local (state) surveyors in the course of creating new platted

areas or lots under the authority of state, county, and city platting laws.

These corners have wide acceptance as not being subject to rejection or modification, much like the acceptance federally established section and quarter corners.

b. Original corners set by local surveyors while subdividing federally surveyed sections.

These corners are not so universally accepted. There are federal rules and procedures for subdivision of sections. Those rules, as revealed in BLM manuals and circulars, have been adopted by law in Washington as legal section subdivision procedures. Federal law gives local surveyors the authority to set original section subdivision corners. Washington State law gives local registered surveyors the authority to establish original corners. On occasion these corners, established with the proper authority, have been rejected by registered surveyors. That rejection has two sources. The corner may be judged to have been set using improper methods or procedures. An example would be the rejection of a center quarter section corner monument because it was established using an incorrect monument for one of the four controlling quarter section corners. The second source of corner monument rejection is the establishment of a monument at a location incorrect mathematically to such a degree that the corner is deemed unacceptable. A center quarter section corner may have been set using the wrong backsight with the result that it is tens of feet from where it was intended to be. Rarely, if ever, are these two criteria used to reject an original corner monument set by a federal surveyor, although the criteria have been applied to federal dependent resurveys. Rejection based on the first criterion, improper methods or procedures, is valid; it has been employed by federal surveys in the rejection and acceptance of local corners. Rejection based on the second criterion, inaccurate monument location, must be tempered by an evaluation, probably subjective, of the required positional accuracy, which is the topic of the following section.

c. Corner monuments set to replace missing corners set in the course of creating platted areas or lots under the authority of state, county, and city platting laws.

Surveyors generally agree that such corners monuments must be set in the location of the original monument and if the original location is lost the monument must be set using some sort of proportioning technique. Monuments having satisfied that requirement are then judged based on the accuracy of the retracement position.

d. Corner monuments set to replace missing corners set by local surveyors while subdividing federally surveyed sections.

Retracements of previously surveyed section subdivision corners are sometimes treated differently from retracements of corners established under state and local platting authority. These corners, if lost, may be replaced by corner monuments set at theoretical locations calculated from the controlling GLO section and quarter corners. If the original location can be determined from references or other means the corner monument should be reestablished in the original location, not in a new location calculated from ties to GLO corners. Only by respecting the original locations of corner monuments can land boundaries be

stabilized.

v. Required Accuracies

The required accuracy for federal public land surveys was first addressed in the Act of February 11, 1805, and incorporated into United States Code, Title 43, Chapter 18. The emphasis is on what is possible and practical.

> *§ 752. Boundaries and contents of public lands; how ascertained ... and the corners of half and quarter sections, not marked on the surveys, shall be placed **as nearly as possible** equidistant from two corners which stand on the same line.*
> *§ 753. Lines of division of half quarter sections; how run ... on the principles directed and prescribed by section 752 of this title ... shall in like manner **as nearly as practicable** be subdivided into half and quarter-sections ... shall in like manner, **as nearly as practicable**, be subdivided into quarter quarter-sections.*

GLO and BLM survey instructions have issued "limits of closure", which are different from the "rectangular limits" used to define when a section is "regular" and considered to have exactly 640 acres. The limit of closure in the 1973 BLM Manual is set at one part in 905.

Washington State law has linear closure standards of 1 part in 5,000 or 1 part in 10,000 depending on the type of survey.

Closure standards are valuable only for determining whether a survey meets the requirements of the governing body authorizing the survey. A monument may not have an accuracy requirement if it was set under local authority prior to there being any local accuracy standards.

Accuracy standards should be used with great caution when determining whether a monument established under federal or local authority is to be accepted. There are several other criteria to be considered, some of which are mentioned in the BLM memoranda which follow.

vi. Role of Accepted Corners in Section Subdivision

Once a section subdivision corner monument is accepted it "has all the authority and significance of an identified original corner." Those words appear in the 1973 BLM Manual in reference to corners originally established by federal survey. A 1989 BLM memorandum, reproduced below, extends the concept to apply to original section subdivision corners, whether set by federal or local surveyors. The consequence of this principle can be illustrated by a center quarter section corner monument. If a found monument is accepted as the corner the subdivision of the quarter sections are surveyed based on the actual position of the monument and not on the mathematically calculated intersection of straight lines connecting the opposite quarter section corners. The same idea is applied to any accepted section subdivision monument. The actual monument position is used to determine the position of lines and previously unmonumented corners; the mathematically calculated position has no effect on the section subdivision.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Oregon State Office
P.O. Box 2965 (1300 N.E. 44th Ave.)
Portland, Oregon 97208

In Reply Refer to:

9600 (942)

October 29, 1992

Instruction Memorandum No. OR-93- 020
Expires 9/30/94

To: All District Managers

From: State Director

Subject: Acceptance of Locally Established Survey Corners

There has been considerable discussion in the past about the proper utilization of survey corners established by private land surveyors and identified in a BLM dependent resurvey or subdivision of sections survey. These discussions have involved those situations where local corners, directly or indirectly, control or define Federal lands. As a result of these discussions, policies and guidelines have been developed and will pertain to locally established aliquot part corners (1/16, 1/64, 1/256, and 1/1024).

The role of the local surveyor in establishing corners to identify private lands is well defined. Section 3-76 of the Manual of Surveying Instructions, 1973 states, "The local surveyor is employed as an expert to identify lands which have passed into private ownership. This may be a simple or a most complex problem, depending largely upon the condition of the original monuments as affected principally by lapse of time since the execution of the original fractional parts shown upon the approved play. In this capacity, the local surveyor is performing a function contemplated by law." Therefore, local corners acceptably established to mark the aliquot parts of a section are in fact the aliquot part corners and will be accepted and identified as such, even though a precise measurement may identify small technical errors in positioning.

Section 6-28 of the Manual states, "Once accepted, a local point of control has all the authority and significance of an identified original corner." This section of the Manual is referring to local perpetuations or restorations of corners established in the original survey. However, the same principle applies to locally established aliquot part corners: once accepted, a locally established aliquot part corner has all the authority and significance of an aliquot part corner established by the Bureau of Land Management.

The following guidelines should be used to help evaluate local corners for acceptance:

1. Was the corner established by a surveyor who was qualified to perform land surveys according to State regulations?

2. Is the record complete or are there ambiguities which cannot be satisfactorily resolved?
3. Was the corner established using proper control and proper procedures? Were the areas returned on the official plat of survey protected?
4. How long has the corner been in place and has it been relied upon by local landowners to mark their boundaries?
5. Has the corner been used by other surveyors?
6. Has the corner been used in deeds to convey land?
7. Are errors in positioning minor technical errors or gross error?
8. Is the Federal land public domain, reacquired, or reconveyed?
9. Can you defend your decision if challenged? On what basis?

If the evaluation of a locally established corner determines that it meets the criteria of the guidelines, it is to be accepted by the BLM survey as the proper position for the corner. It is important that corners accepted by a BLM survey are adequately monumented, i.e., a metal monument with a metal cap marked to identify the corner, firmly set, and in good condition. If a corner is adequately monumented, it is not necessary to remonument the position with a BLM monument.

This memorandum does not intend to resolve those instances of possible corner acceptance complicated by factors such as more than one locally established corner, ambiguous or incomplete records, or corners which are acceptably positioned in latitude only or in departure only. There will always be those surveying situations involving locally established corners which cannot be easily resolved, and field surveyors should coordinate with the office team surveyor, Branch of Cadastral Survey and Mapping Sciences, to determine the proper course of action.

It is important to differentiate between establishing aliquot part corners and reestablishing lost original corners. Normally, local corners and records will not be used as a basis for reestablished lost original corners by proportionate measurement. However, when a careful and thorough examination concludes that it is the best available evidence to determine the position of the original corner, it may be used. Before a decision is made, the situation should be fully discussed with the office team surveyor, Branch of Cadastral Survey and Mapping Sciences.

If there are any questions, or clarification of information contained in this memorandum is needed, please contact the Chief, Branch of Cadastral Survey and Mapping Sciences.

Deputy State Director for Operations

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

IN REPLY REFER TO

March 7, 1988

9620 (720)

Instruction Memorandum No. 88-287
Expires 9/30/89

To: State Directors

From: Director

Subject: Establishment of Minor Subdivision Corners

There comes a time when an issue has been debated long enough and a policy decision must be stated. The issue of establishing/reestablishing minor subdivision corners along section lines between other marks/corners of the original survey has reached that point. The following discussion and statements represent the rationale of our Division of Cadastral Survey and are the policy and the interpretation of the Manual of Surveying Instructions, 1973.

The law for original surveys is very clear and is stated in 43 USC 752:

> "First. All the corners marked in the surveys, returned by the Secretary of the Interior or such agency as he may designate, shall be established as the proper corners of sections, or subdivisions of section, which they were intended to designate; and the corners of half and quarter sections, not marked on the surveys, shall be placed as nearly as possible equidistant from two corners which stand on the same line." The 43 USC 753 prescribes the lines of quarter sections to be in accordance with 43 USC 752.

The second portion of the quoted 43 USC 752 states: "the corners of half and quarter sections, not marked on the surveys, shall be placed as nearly as possible equidistant from two corners which stand on the same line." (Emphasis added) There is no controversy as long as the sections are regular and there are no intermediate corners/marks between the section corners and the quarter section corners because then both statements can be carried out.

Thus, the general rule is very clear and stated under 3d in 1 LD 675; dated March 13, 1883:

> "3d. That quarter quarter corner not established by the government surveyors must be planted equidistant and on line between the quarter section and section corner."

Also, in 1 LD 675:

> "From the foregoing it will be plain that extinct corners of the government surveys must be restored to their original locations, whenever it is possible to do so; and hence resort should always be first had to the marks of the survey in the field. The locus of the missing corner should be first identified on the ground by the aid of the mound, pits, line trees, bearing trees, etc., described in the field notes of the original survey." (Emphasis added)

Again, in 1 LD 676:

> "Where retracements of lines have to be made for the purpose of either testing or relocation of a missing corner, or by direct measurement between known corners intersecting at the point sought to be reestablished, it will almost invariably happen that a difference of measurement is developed between the original measurement, as stated in the field notes, and the new measurement made for the purpose of reestablishment or proof. When the differences occur, the surveyor must in all cases re-establish or prove his corners at intervals proportionate to those given in the field notes of the original survey. From this rule there can be no departure, since it is the basis upon which the whole operation depends for accuracy and truth."

There are at least five exceptions to the general rule of establishing 1/16 section corners equidistant and on line between the 1/4 section corners." The following are taken from the Manual:

> First: "3-91. Reasonable discrepancies between former and new measurements may generally be expected when retracing the section boundaries. The shortage or surplus is distributed by proportion in establishing a sixteenth-section corner. For example: The length of the line from the quarter-section corner on the west boundary of section 2 to the north line of the township, by the official survey was reported as 43.40 chains, and by the county surveyor's measurement was found to be 42.90 chains. The distance which the sixteenth-section corner should be located north of the quarter-section corner would be determined by proportion as follows: As 43.40 chains, the official measurement of the whole distance, is to 42.90 chains, the county surveyor's measurement of the same distance, so is 20 chains, original measurement, to 19.77 chains by the county surveyor's measurement. By proportionate measurement in this case the sixteenth-section corner should be set at 19.77 chains north of the quarter-section corner, instead of 20 chains north of said corner, as represented on the official plat. In this manner the discrepancies between original and new measurements are equitably distributed." (Emphasis added)

> Second: "3-103. In extending fragmentary surveys, first consideration is given to the completion of partially surveyed sections. If outlying portions of sections have been returned as surveyed on the previous plat, it is usually necessary to complete the survey of each section in such a way as to protect acquired rights. The procedure adopted must fix the remaining quarter-section corners in a position which will control the center lines as necessary to retain the form of the original areas within reasonable limits."

The acreage to the previously patented subdivisions, in the above example, may determine the positions of the 1/16 sec. cors. at other than midpoint.

> Third: "5-41. When an original closing corner is recovered off the line closed upon and the new monument is established at the true point of intersection, the original position will control in the proportionate restoration of lost corners dependent upon the closing corner. In a like manner the positioning of sixteenth-section corner(s) or lot corner(s) on the closing line, between the quarter-section corner and the closing corner, will be based on the measurement to the original closing corner." (Emphasis added)

> Fourth: "5-18. Line Trees:
> Under the law, a definitely identified line tree is a monument of the original survey. It properly is used as a control point in the reestablishment of lost corners by the appropriate method of proportionate measurement. In this case it is treated just as is a recovered corner, and it becomes an angle point of the line." (Emphasis added)

The Supreme Court has defined "all corners marked" to include line trees or natural objects. (Newsom vs. Pryor's Lessee, 20 U.S. 7, and Ayers vs. Watson, 137 U.S. 584.) These marks are the footsteps of the original surveyor and are paramount in the ranking of evidence in a subsequent retracement of those lines. This section, (5-18) is interpreted by this office to pertain both to the reestablishment of lost corners and to the establishment/reestablishment of minor subdivision corners.

> Fifth: "6-28. Once it is accepted, a local point of control has all the authority and significance of an identified original corner. The influence of such points is combined with that of the previously identified original corners in making final adjustments of the temporary points. The surveyor must therefore use extreme caution in adopting local points of control. These may range from authentic perpetuations of original corners down to marks which were never intended to be more than approximations. When a local reestablishment of a lost corner has been made by proper methods

> without gross error and has been officially recorded, it will ordinarily be acceptable. Monuments of unknown origin must be judged on their own merits, but they should never be rejected out of hand without careful study. The age and the degree to which a local corner has been relied on by all affected landowners may lead to its adoption as the best remaining evidence of the position of the original corner. The surveyor must consider all these factors. However, he cannot abandon the record of the original survey in favor of an indiscriminate adoption of points not reconcilable with it.
>
> The field-note record of the resurvey should clearly set forth the reasons for the acceptance of a local point where it is not identified by actual marks of the original survey. Recognized and acceptable local marks will be preserved and described. Where they are monuments of a durable nature, they are fully described in the field notes and a full complement of the required accessories recorded, but without disturbing or re-marking the existing monument. New monuments are established if required for permanence, in addition to, but without destroying the evidence of the local marks."

This section is interpreted, by this office, to pertain both to the reestablishment of lost corners and to the establishment/reestablishment of minor subdivision corners.

Attached are copies of six letters/memoranda with dates beginning in 1927, which along with the two memorandums on page A 3-5 of the Casebook, state the Bureau's policy over the years and the rationale used, as stated in Manual section 5-23:

> "5-23. Existing original corners may not be disturbed. Consequently, discrepancies between the new measurements and the measurements shown in the record have no effect beyond the identified corners. The differences are distributed proportionally within the several intervals along the line between the corners."

The interpretation of this section is clear, i.e. distances are proportioned between corners and not beyond a corner. This represents the most basic tenet of retracing the Public Land Survey System; which is, all marks of the original surveyor are equal in importance and are the surveyor's footsteps.

In summary and to reemphasize the above stated policy, the position of a minor subdivision corner along an existing section line, in the absence of acceptable evidence at the corner, is at the same proportionate ratio as all other new or missing corners between the marks of the original survey.

If there are any questions on this policy, please contact the Division of Cadastral Survey, FTS 653-8798.

James M. Parker
Assistant Director,
Support Services

6 - Attachments
1 - Memo: Fixation of point for corner not established in original survey, dated August 3, 1927 (3 pp)
2 - Letter to H.C. Lawrence, dated November 4, 1957 (2 pp)
3 - Letter to Williams S. Cameron, Forester, dated March 10, 1960 (1 p)
4 - Letter to Richard L. Floyd, dated July 7, 1966 (1 p)
5 - Memorandum: Final returns, T. 6 N., R. 1 E., Salt Lake Meridian, Utah, dated May 24, 1971 (2 pp)
6 - Memorandum: Survey Procedures and Fractional Sections, dated October 14, 1983 (1 p)

DNR policy from 1996 on the use of accepted minor subdivision corners

WASHINGTON STATE DEPARTMENT OF
Natural Resources

JENNIFER M. BELCHER
Commissioner of Public Lands
KALEEN COTTINGHAM
Supervisor

MEMORANDUM

December 3, 1996

TO: Region Surveyors

FROM: David Steele, Survey Manager
Resource Planning and Asset Management Division

SUBJECT: Procedures for Acceptance and Use of Minor Subdivision Corners

How to use accepted minor subdivision corners was discussed during an April 9, 1996, Region Surveyor's meeting. On April 10 the BLM was consulted regarding the issue and it became clear that a procedure could be issued which was in accord with the national BLM policy and with the implementation of that policy by the Oregon State Office. A draft procedure was issued on April 15. Region surveyors have unanimously employed and approved of the procedure, and so it is now issued in final form.

Procedures for Acceptance and Use of Minor Subdivision Corners

Section 1
Minor subdivision corner monuments which, if accepted, would be controlling corners for a DNR survey will be searched for and tied. It is not necessary to search for a controlling monument if there are no records, testimony, or occupation lines to lead one to suspect the existence of a monument at that position.

Section 2
In all section subdivisions, a theoretical section subdivision will be developed in order to test found minor subdivision monuments for acceptance. Only in exceptional cases will monuments be accepted without first testing for proximity to a calculated position. If the decision is made to accept found corners, the theoretical subdivision coordinates will be put aside and a fresh section subdivision will be calculated using the accepted monument positions.

Section 3

Once it is accepted, a local point of control (in this memo: a minor subdivision corner) has all the authority and significance of an identified original corner. See BLM 1973 Manual of Instructions, Section 6-28.

a) Subdivision lines will run to local monuments of control. The measured coordinate of the local monument will be used instead of the theoretical coordinate. This eliminates confusion about what our measurements represent. For example, if a C-S 1/16 corner monument is found and accepted, then the north-south center line will consist of two straight lines, one from the south 1/4 corner to the C-S 1/16 corner and the other from the C-S 1/16 corner to the north 1/4 corner.

b) Proportions will be made between corners and not beyond a corner. See BLM 1973 Manual of Instructions, Section 5-23. For example, the C-S 1/16 corner above, once accepted, would control the positioning of the center 1/4 corner. As another example, an accepted NW 1/16 corner would generally not be used to control any corner other than those interior to the northwest quarter of the section.

A BLM example of using accepted corners. The Center Quarter Section Corner was set by a private surveyor using an incorrect position for the North Quarter Section Corner for control. It was not accepted as the Center of Section monument but was accepted as being a monument of and an angle point of the east-west section centerline.

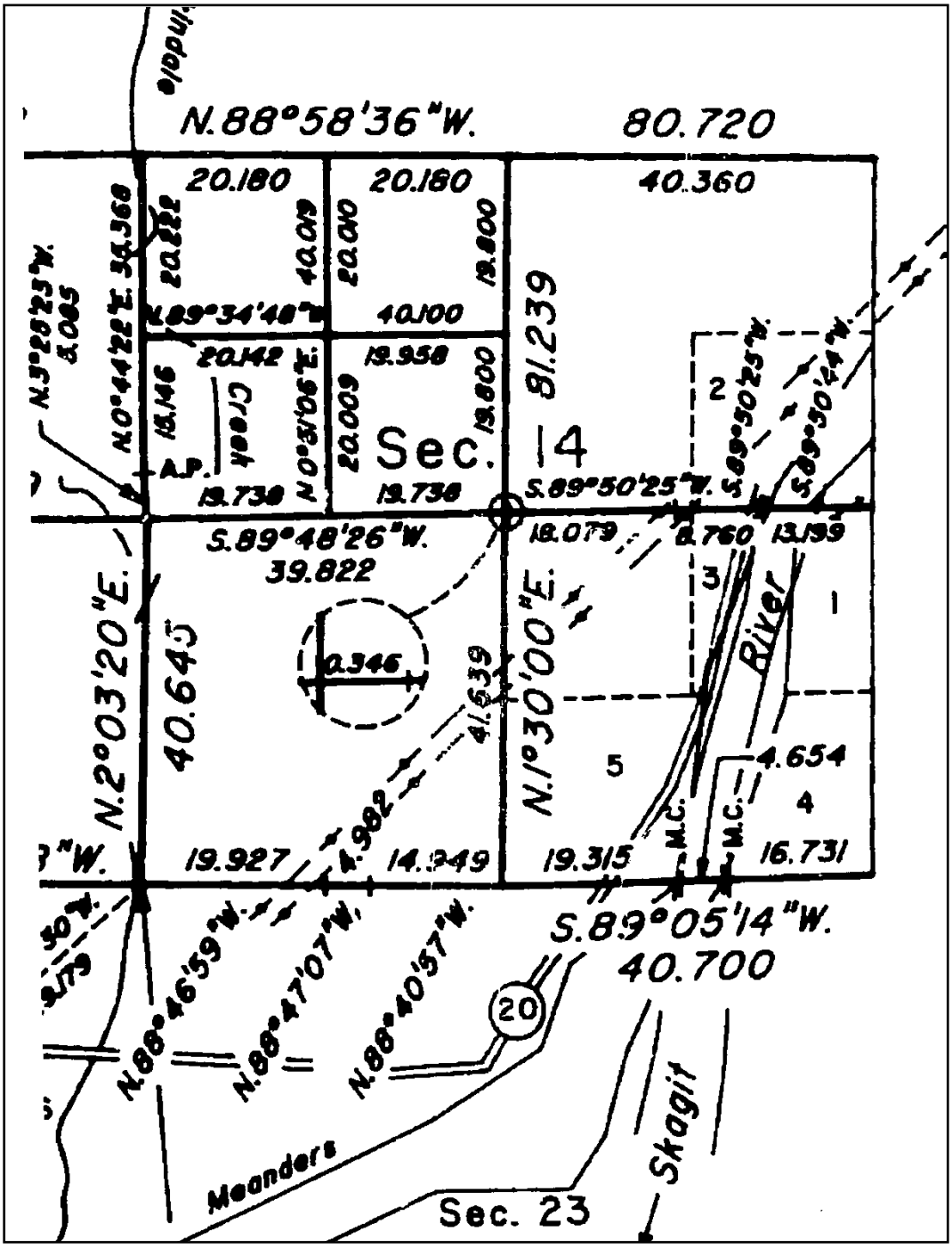


Figure 54

An example of using accepted corners to subdivide a section.
The Center ¼ corner is controlled by the accepted C-S 1/16.
The SW 1/16 corner is controlled by the accepted C-E-SW 1/64.
The E 1/16 corner on the south section line is controlled
by the accepted W-E 1/64 corner.

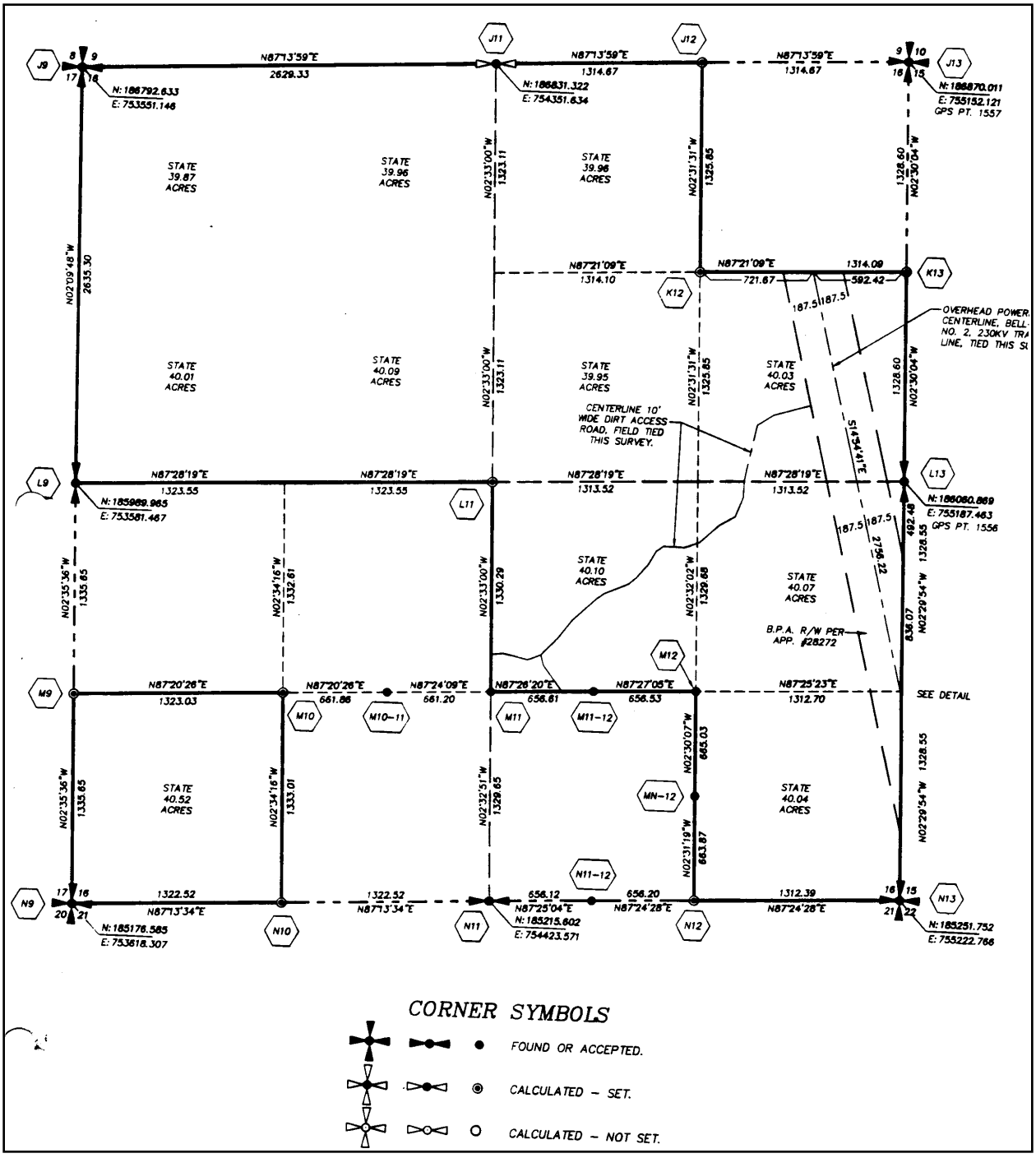


Figure 55

3. Subdivision of Regular Sections

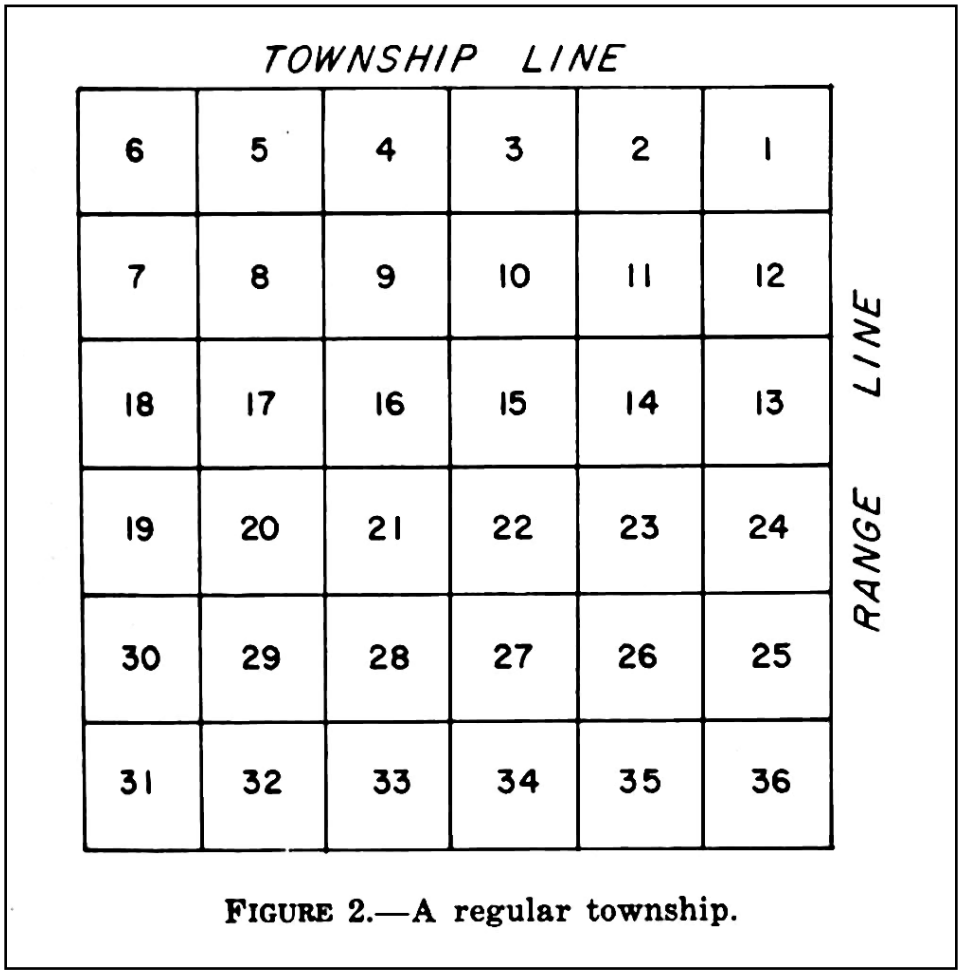


FIGURE 2.—A regular township.

Figure 56

i. Definition of Regular Section

A Regular Section is a section whose boundaries are within rectangular limits, with no lots, and 16 aliquot part legal subdivisions, or, whose boundaries were considered within the rectangular limits.
(Bob Dahl, Memo dated December 19, 2006)

ii. Rectangular Limits

Rectangular Limits in GLO and BLM instructions define the limits to which a section can be measured and still be a regular section and be considered to have exactly 640 acres. This is not the same as the permitted error of closure.

Rectangular Limits in the 1864 Manual

The east-and-west section lines, except those terminating in the west boundary of the township, are to be within one hundred links of the actual distance established on the south boundary line of the township for the width of said tier of sections.

The north boundary and south boundary of any one section, except in the extreme western tier, are to be within one hundred links of equal length.

Rectangular Limits in the 1881 Manual

The east-and-west section lines, except those terminating in the west boundary of the township, are to be within eighty links of the actual distance established on the south boundary line of the township for the width of said tier of sections, and must close within eighty links north or south of the section corner.

The north boundary and south boundary of any one section, except in the extreme western tier, are to be within eighty links of equal length.

Rectangular Limits in the 1890 Manual

The east-and-west section lines, except those terminating in the west boundary of the township, are to be within eighty links of the actual distance established on the south boundary line of the township for the width of said tier of sections, and must close within fifty links north or south of the section corner.

The north boundary and south boundary of any one section, except in the extreme western tier, are to be within eighty links of equal length.

Rectangular Limits in the 1894 Manual

In any range of sections, the difference between the true bearing of a latitudinal section line and that of the south boundary of the range, shall not exceed 21 minutes of arc.

The latitudinal section lines, except those terminating in the west boundary of the township, shall be within fifty links of the actual distance established on the south boundary line of the township for the width of the range of sections to which they belong.

The north boundary and the south boundary of any one section, except in the extreme western range of sections, shall be within fifty links of equal length.

Rectangular Limits in the 1894 Manual

Upon retracement thereof, an old township boundary may be found to be defective in one or all of three qualifications, viz: alinement, measurement, and position, as follows:

In alinement: when any portion thereof deviates more than twenty-one minutes of arc from a true meridian or latitude line.

In measurement: when the length of the whole boundary or some portion thereof, between two successive corners, is proved to be greater or less than the distance certified in the preceding survey, at a rate exceeding 25 links to the half mile.

In position: when the corners originally established on such a boundary can not be connected with the corners on the opposite regularly established boundary, by lines which do not deviate more than twenty-one minutes of arc from true meridian or latitude lines.

Rectangular Limits in the 1973 BLM Manual

BLM Manual 3-34. The amounts by which a section, or its aliquot parts, may vary from the ideal section and still be considered regular are referred to as the rectangular limits:

(1) For alinement, the section's boundaries must not exceed 21' from cardinal in any part, nor may the opposite (regular) boundaries of a section vary more than 21'.

(2) For measurement, the distance between regular corners is to be normal according to the plan of survey, with certain allowable adjustments not to exceed 25 links in 40 chains.

iii. A regular section is composed exclusively of aliquot parts.

From the Glossaries of BLM Surveying and Mapping Terms

ALIQUOT -Contained an exact number of times in another; a part of a measurement that divides the measurement without a remainder. See ALIQUOT PARTS.

ALIQUOT PARTS -Legal subdivisions, except fractional lots, or further subdivision of any smaller legal subdivision, except fractional lots, by **division into halves or fourths** ad infinitum. See LEGAL SUBDIVISION; SUBDIVISION, SMALLEST LEGAL and MINOR SUBDIVISION.

The NE 1/4 is an aliquot part. The S1/2 of the NE1/4, the SE1/4 of the NW1/4, and the W1/2 of the NW1/4 of the SE1/4 are other examples of aliquot parts. The S1/3 of the NW1/4 is not an aliquot part.

iv. Instructions in the BLM Manual

There are two steps in subdividing a regular section into aliquot parts, as outlined in the BLM manual.

(1) Subdivision of Sections Into Quarter Sections

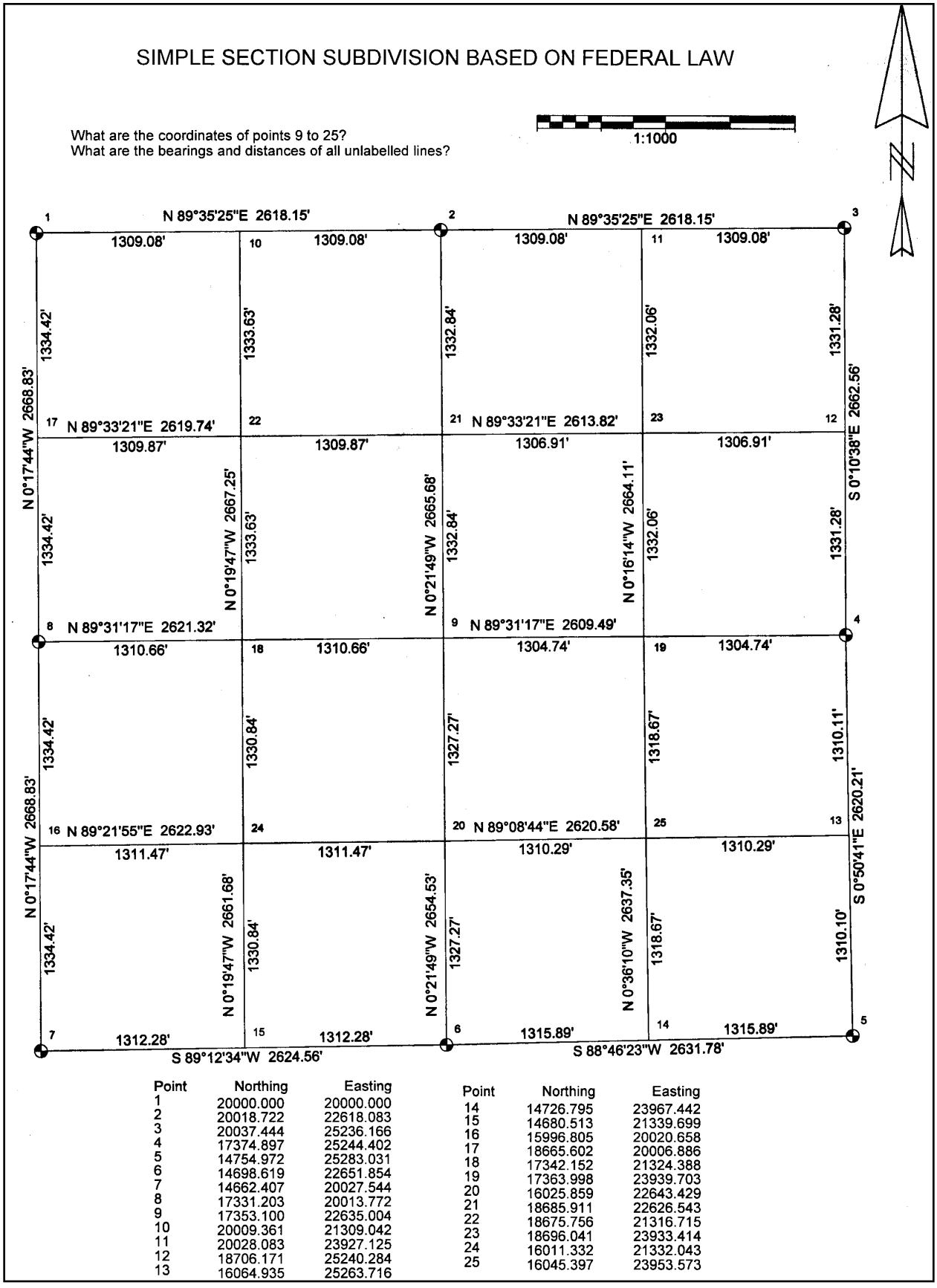
3-87. To subdivide a section into quarter sections, run straight lines from the established quarter-section corners to the opposite quarter-section corners. The point of intersection of the lines thus run will be the corner common to the several quarter sections, or the legal center of the section.

(2) Subdivision of Quarter Sections

3-89. Preliminary to the subdivision of quarter sections, the quarter-quarter- or sixteenth-section corners will be established at points midway between the section and quarter-section

corners, and between the quarter-section corners and the center of the section, except on the last half mile of the lines closing on township boundaries, where they should be placed at 20 chains, proportionate measurement counting from the regular quarter-section corner.

The quarter-quarter- or sixteenth-section corners having been established as directed above, the center lines of the quarter section will be run straight between opposite corresponding quarter-quarter- or sixteenth-section corners on the quarter-section boundaries. The intersection of the lines thus run will determine the legal center of a quarter section.



Point	Northing	Easting
1	20000.000	20000.000
2	20018.722	22618.083
3	20037.444	25236.166
4	17374.897	25244.402
5	14754.972	25283.031
6	14698.619	22651.854
7	14662.407	20027.544
8	17331.203	20013.772
9	17353.100	22635.004
10	20009.361	21309.042
11	20028.083	23927.125
12	18706.171	25240.284
13	16064.935	25263.716

Point	Northing	Easting
14	14726.795	23967.442
15	14680.513	21339.699
16	15996.805	20020.658
17	18665.602	20006.886
18	17342.152	21324.388
19	17363.998	23939.703
20	16025.859	22643.429
21	18685.911	22626.543
22	18675.756	21316.715
23	18696.041	23933.414
24	16011.332	21332.043
25	16045.397	23953.573

Figure 57

4. Subdivision of Closing Sections

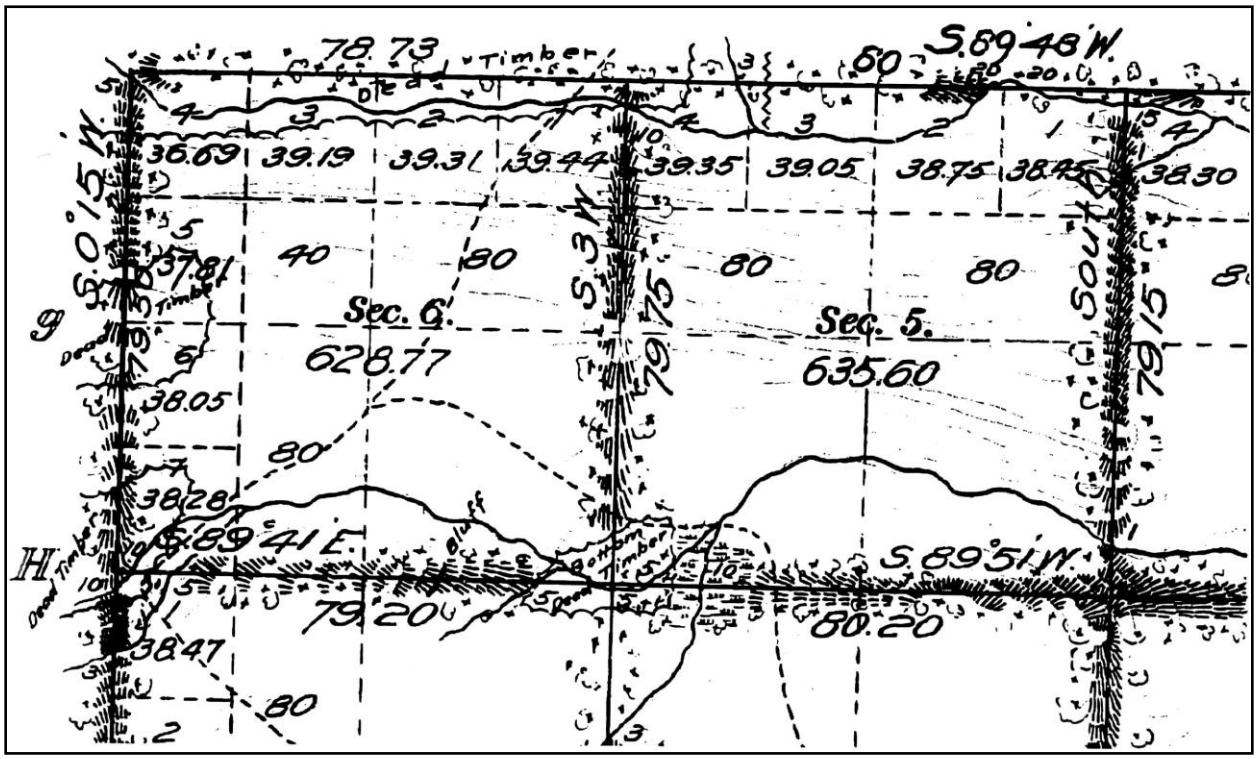


Figure 58

i. Definition of Irregular Section

An Irregular Section is a section having one or more boundaries exceeding the rectangular limits, or containing one or more lots, or is not a regular section.
(Bob Dahl, Memo dated December 19, 2006)

ii. Definition of a Closing Section

A Closing Section is a section made irregular by closing into a township boundary.

iii. Areas and Parenthetical Distances

From BLM Glossary:

> *"Distances noted on the plats in parentheses are those regular and fractional portions of lines constituting the boundaries of the quarter-quarter sections and fractional subdivisions bounded thereby. Parentheses are used where the record is not supplied by the field notes, indicating that the distance was not measured on the ground. The figures show what was used in the calculation of areas. The same lengths are to be adopted proportionately whenever there is a need for an establishment of sixteenth-*

section corners on the section boundaries, and for control points for the subdivision of sections."

Most older GLO plats do not show the parenthetical distances; they show only the areas of Government Lots. Certain parenthetical distances are needed in order to subdivide closing sections. They are needed in order to compute some of the 1/16 corners in a closing section. One can first calculate the parenthetical distances and then see if the area calculations are consistent with the parentheticals. Sometimes there are errors in the areas shown. Usually the areas shown will help us in calculating the parentheticals.

Parentheticals on the BLM Sample Plat

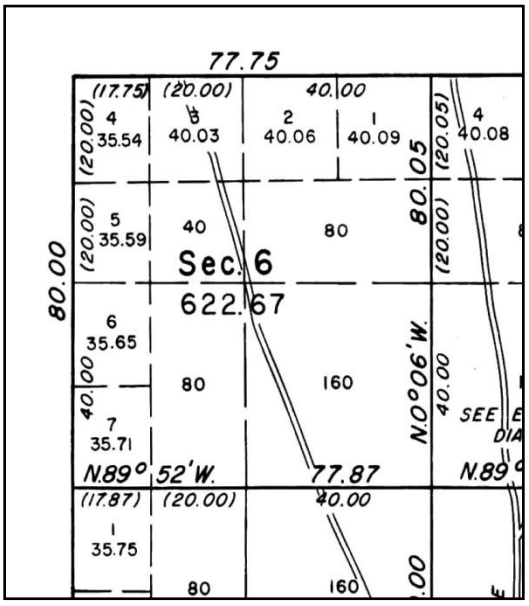


Figure 59

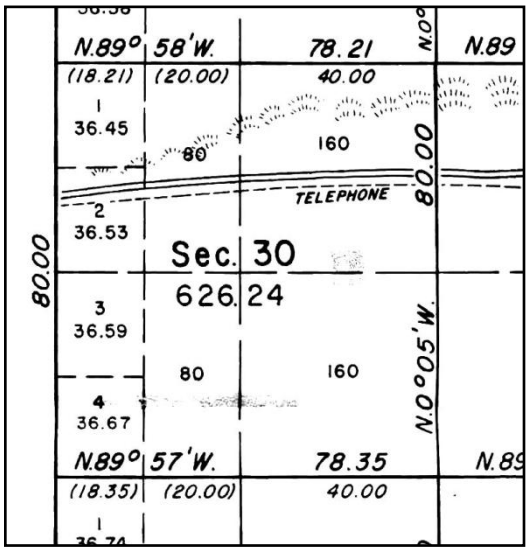


Figure 60

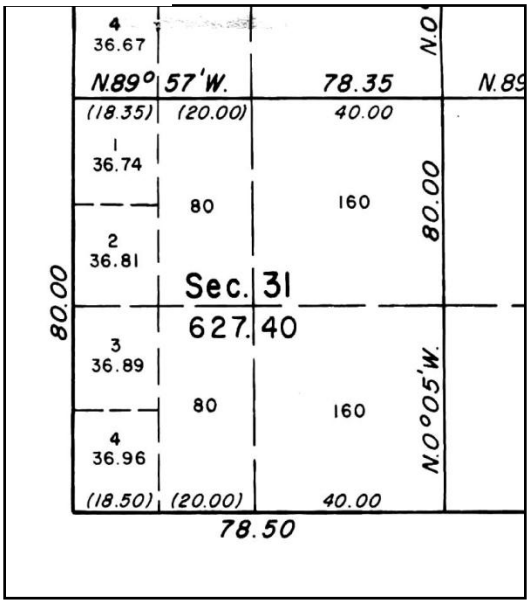


Figure 61

In order to subdivide section 6, in Figure 62 below, one needs to be able to proportion the center north 1/16, the north 1/16 on the east and west lines, the center west 1/16 corner, and the west 1/16 corners on the north and south lines.

The parenthetical distances along those lines are required for the proportioning.

One should consider the areas when calculating the parenthetical distances along the section centerlines.

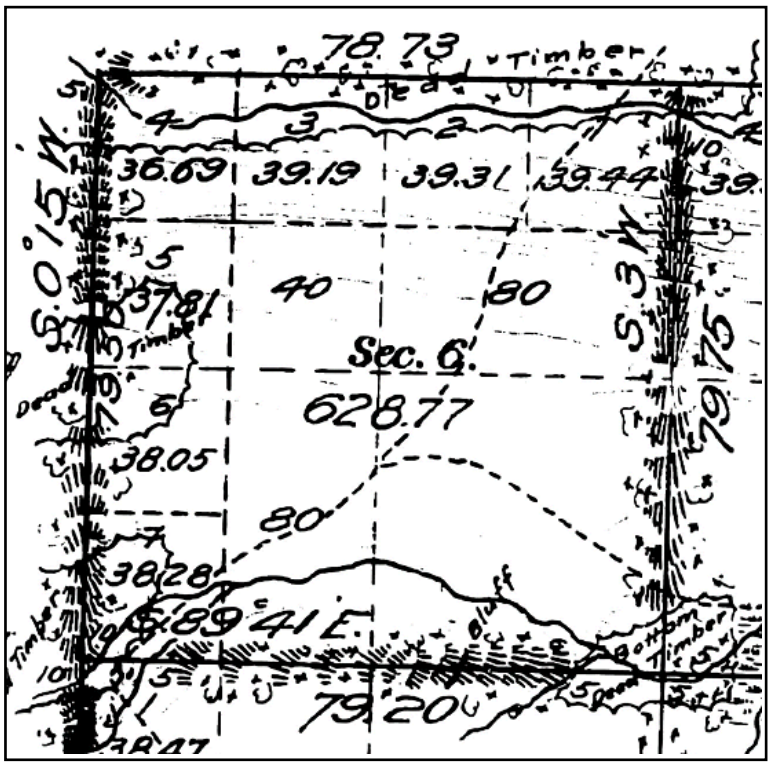


Figure 62

iv. Use Acreages to Compute Parenthetical Distances

An Acre is 10 Square Chains

To compute the area of a Government Lot that is 20 chains wide or high, add the two side distances, in chains, together. The reason for this is that every chain in height or width of the lot, along the side that is not 20 chains, adds 2 acres to the size of the lot; 1 chain x 20 chains = 20 square chains = 2 acres. Twice the average height of the lot in chains is the acreage of the lot. The sum of the two side distances is twice the average height of the lot. See Figure 63 below.

The distance of the line separating two lots, each 20 chains wide (or high), is the sum of areas divided by four. This is because the area of a figure 40 chains wide is four times the average height of the area. The length of line dividing the area into two 20 chain wide lots is the average height of the two lots. See Figure 64 below.

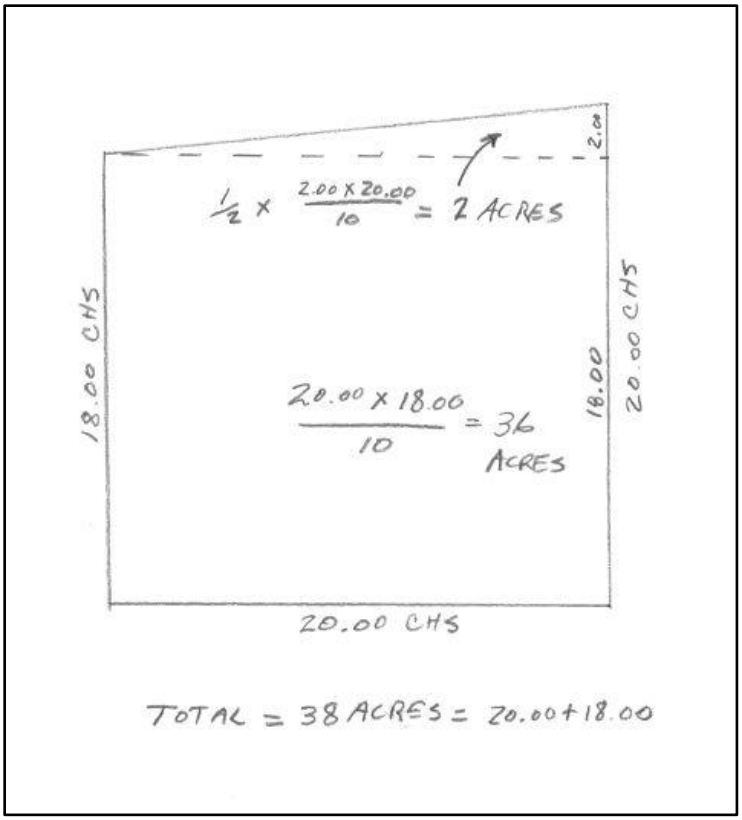


Figure 63

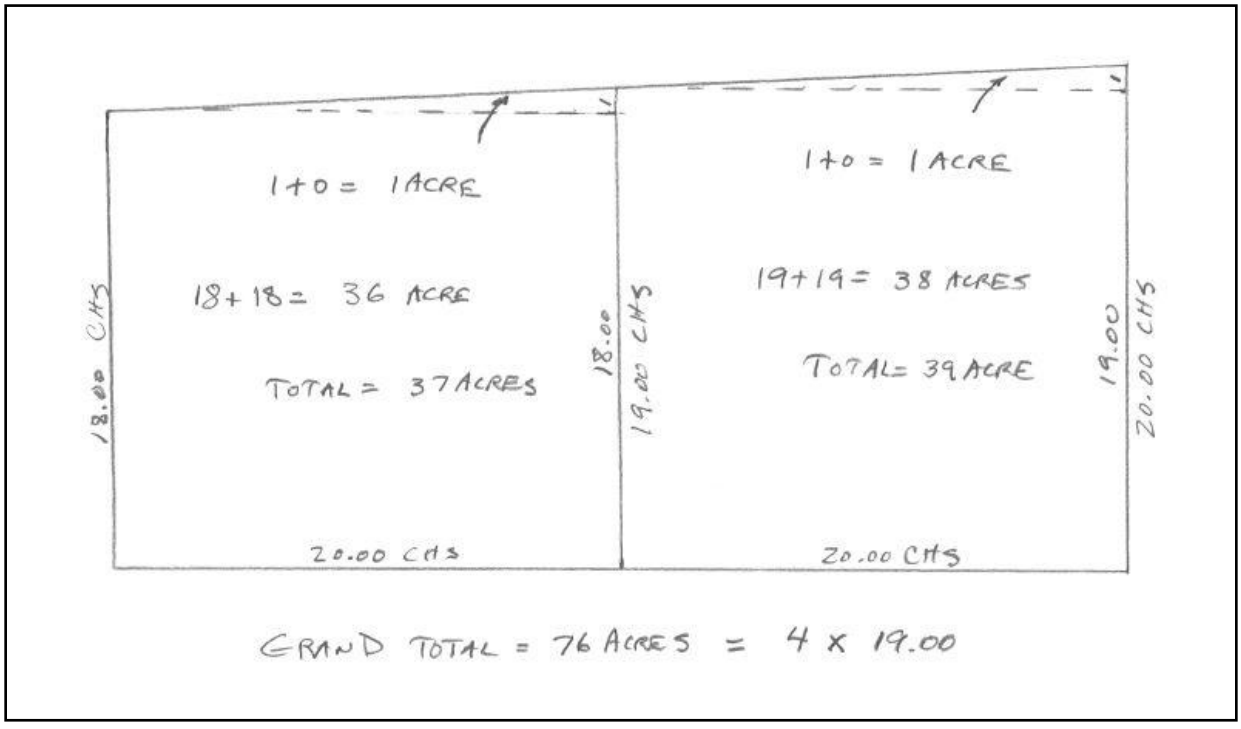


Figure 64

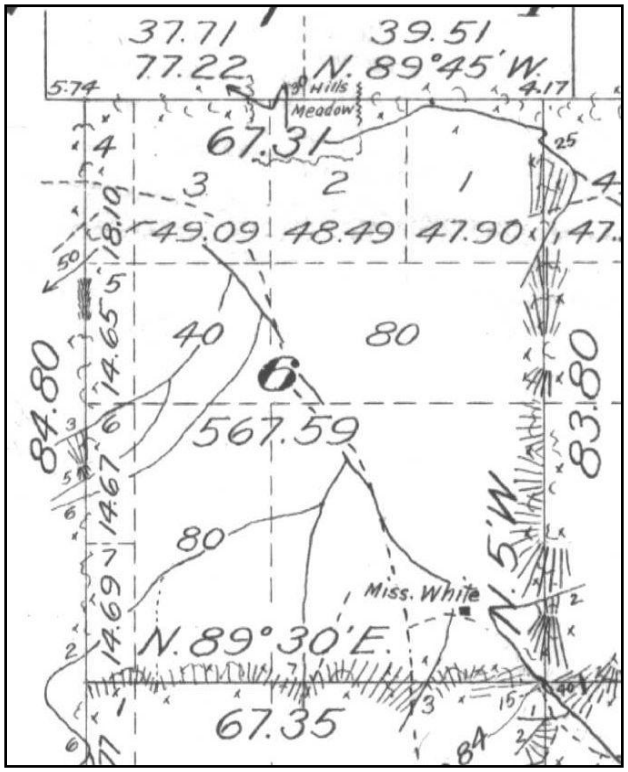


Figure 65

Compute the parenthetical distances in Figure 65 above:
The distance between lots 2 and 3 is (49.09 + 48.49) / 4 = 24.395.
The distance between lots 1 and 2 is 47.90 – 23.80 = 24.10.
The distance between lots 2 and 3 is 48.49 – 24.10 = 24.39.
The correct solution is not always the easy solution; here it is not the average of the parenthetical distances on opposite section lines. The distance between lots 2 and 3 is not (23.80 + 24.80) / 2 = 24.30

The distance between lots 5 and 6 is (7.35 + 7.31) / 2 = 7.33.
The distance between lots 5 and 6 is (14.67 + 14.65) / 4 = 7.33.
The distance between lots 6 and 7 is 14.69 – 7.35 = 7.34.
In this case the mean of opposite parenthetical distances gives the right answer. The distance between lots 5 and 6 is 14.67 – 7.34 = 7.33.

v. Computation of Areas from the 1973 Manual

9-24. The deficiency in area which results from the convergency of meridians is placed normally in the fractional lots adjoining the west boundary of the township. Sections 7, 18, 19, 30, and 31 each usually contains lots 1 to 4, inclusive, whose meridional dimensions are all an even 20,000 chains; the dimensions of the latitudinal boundaries of these lots are computed proportionately from the fractional measurements ascertained on the section lines. The area, in acres of each lot, is then found simply by adding the lengths, in chains, of its north and south boundaries.

9-25. For example, taking section 30, shown on the specimen plat, the dimensions of the latitudinal boundaries and the areas are found as follows:

	(1)	(2)	(3)	(4)
N	18.21	18.245	18.28	18.315 chs.
S	18.245	18.28	18.315	18.35 chs.
	36.455	36.525	36.595	36.665 acres
	36.45(+)	36.53 (-)	36.59(+)	36.67(-) acres

9-26. The areas of lots 5, 6, and 7, section 6, are ascertained similarly, **making due allowance, when calculating the length of the north boundary of lot 5, for any material variation from 20.00 chains in the meridional dimension of lot 4.**

9-27. The surplus or deficiency in area which results from the discrepancy in the meridional measurements between the exterior boundaries and the subdivisional lines is placed normally in the fractional lots adjoining the north boundary of the township. Sections 1 through 5 each usually contains lots 1 through 4, whose dimensions on their latitudinal boundaries are all treated as an even 20.00 chains; the meridional dimensions of these lots and their areas are computed on the plan heretofore described for the fractional lots adjoining the west boundary of the township.

9-28. The areas of lots 1, 2, and 3, section 6, are ascertained similarly, **making due allowance when calculating the length of the west boundary of lot 3, for the departure across lot 4,** where more or less than 20.00 chains. The area of lot 4, section 6, in acres, equals the product of its mean dimensions in chains, divided by 10.

9-29. The following is an example of ascertaining the areas of the fractional lots in section 6, shown on the specimen township plat:

	(1)	(2)	(3)	(4)
E	20.05	20.037	20.024	20.011 chs.
W	20.037	20.024	20.011	20.000 chs.
	40.087	40.061	40.035	acres

40.09 40.06 40.03 (+) acres

20.005 mean

	(5)		(6)	(7)	
N	17.78	17.81	17.84	17.75	chs.
S	17.81	17.84	17.87	17.78	chs.

35.59 35.65 35.71 acres

17.765 mean

2.0005 x 17.765 = 35.539 acres

35.54 acres

The 1973 Manual does not tell us how to go about "making due allowance when calculating the west boundary of lot 3, for the departure across lot 4" (see 9-28). When a section centerline is not at the midpoint of the section boundary, then the parenthetical distance along the centerline will not be a mean of the parenthetical distances along the section boundaries.

vi. Computation of Areas from the 1894 Manual

The 1894 GLO Manual of Surveying Instructions gives detailed instructions on how to compute areas and parenthetical distances. The methodology is useful for various section subdivision problems. Pay special attention to the meaning and use of the terms "d" and "q" as they will be used in subdivision computations.

1. In regular townships, the tracts of land in each section adjoining the north and west boundaries of such townships, in excess of the regularly subdivided 480 acres (except in section 6), will, in general, be in the form of trapezoids, 80.00 chains in length by about 20 chains in width.

On the plats of such townships, each of said tracts will be divided into four lots, by drawing broken lines at intervals of 20.00 chains, parallel to the ends of the tracts, which will be regarded as parallel to each other.

With the exception of section 6, the south boundaries of sections of the north tier, when within prescribed limits, will be called 80.00 chains

When the above-named conditions obtain, the areas of the lots in any one tract (except in section 6) may be determined, as follows:

Divide the difference between the widths of the ends of the tract by 4; if 3 remains, increase the hundredth figure of the quotient by a unit; in all other cases disregard the fraction; call the quotient thus obtained,

"d"; then, taking the end widths of the tract in chains and decimals of a chain, the areas of the lots, in acres, will be:

Of the smallest lot: twice the width of the lesser end, plus "d";

Of the largest lot: twice the width of the greater end, minus "d";

Of the smaller middle lot: sum of the widths of the ends, minus "d";

Of the larger middle lot: sum of the widths of the ends, plus "d".

A check on the computation may be had by multiplying the sum of the widths, of the ends of the tract by 4; the product should agree exactly with the total area of the four lots.

The proper application of the above rules will always give areas correct to the nearest hundredth of an acre; and, as the use of fractions is entirely avoided, the method is recommended for its simplicity and accuracy.

Example 1. (See Plate IV, section 31.)

The 1/4 difference of latitudinal boundaries is 0.15/4 chains; consequently, "d" is .04 chains; then,

18.35 x 2	*+.04=*	*36.74 acres, the area of lot 1;*
18.50 x 2	*-.04=*	*36.96 acres, the area of lot 4;*
18.50 + 18.35	*-.04=*	*36.81 acres, the area of lot 2;*
18.50 + 18.35	*+.04=*	*36.89 acres, the area of lot 3;*
Check: [18.35 + 18.50] x 4=		*147.40 acres, the area of the four lots.*

The arithmetical operations are here written in detail, for the purpose of illustration; but the practical computer will perform all the work mentally.

2. Section 6. (See Plate I, figs. 6 and 7; and Plate IV.) The areas of lots 5, 6, and 7 may be obtained by the foregoing rules in all cases, except when the township closes on a base line or standard parallel; also, the area of lot 4, provided both meridional boundaries are 80.00 chains in length; when the last condition obtains, the areas of lots 1, 2, and 3 will be equal, and each will contain 40.00 acres.

In any case where the west boundary of sec. 6, is 80.00 chains, and the east boundary either greater or less than 80.00 chains, the areas of lots 1, 2, 3, and 4 will be computed as follows:

Refer to figures 6 and 7 and determine the difference, between the east boundaries of lots 1 and 4 by the following proportion:

N. bdy. sec. 6. : diff. of meridional bdrs. sec. 6::60 chs. : q; then will E. bdy. lot 4 = E. bdy. lot 1 ± q; in which "q" will be added when the east boundary of sec. 6 is less than 80.00 chains (fig. 7.); but subtracted when said east boundary is greater than 80.00 chains (fig. 6).

Now take one third of "q", and add it to the shorter east boundary of lots 1 or 4, as conditions may require, and thereby determine the length of one of the meridional boundaries of lot 2; to which, again add "one third of q", and thus obtain the length of the opposite side of lot 2. The areas of lots 1, 2, and 3, in acres, will be found by taking the sum of their respective meridional boundaries, expressed in chains and decimals of a chain.

The area of lot 4 may be had by multiplying its mean width by its mean length.

Finally, to test the entire work, multiply the sum of the latitudinal boundaries by 4, and to

the product add the area of the small triangle C A B, if the east boundary is greater than 80.00 chains (fig. 6); but subtract the area of said small triangle if the east boundary is less than 80.00 chains (fig. 7). These operations, correctly performed,

-70

will give the true area of the section, which should agree exactly with the total area of its legal subdivisions, obtained as directed in the preceding paragraphs.

Example 2. (See Plate I, figs. 6 and 7, and Plate IV.)

Compute areas of lots 5, 6, and 7 of sec. 6, as directed in paragraph 1, and illustrated by the example; then write:

chs. chs. chs. chs. chs.
77.75 : 0.05 :: 60.000 : 0.0386 = q^4; 1/3 q = 0.0129

chs.		*chs.*	*chs.*
20.0500	*-*	*0.0386 =*	*20.01, the E. bdy. of lot 4;*
20.0114	*+*	*0.0129 =*	*20.02, the E. bdy. of lot 3;*
20.0243	*+*	*0.0129 =*	*20.04, the E. bdy. of lot 2.*

Then, for the areas of lots 1, 2, 3, and 4, we have:

chs.	*chs.*	*acres.*	
20.05 + 20.04	*=*	*40.09,*	*the area of lot 1;*
20.04 + 20.02	*=*	*40.06,*	*the area of lot 2.*
20.02 + 20.01	*=*	*40.03,*	*the area of lot 3;*
$\frac{20.00 + 20.01}{2}$ *x* $\frac{17.75 + 17.78}{2}$	*=*	*35.54,*	*the area of lot 4.*

Also [17.78 + 17.87] x 3	*=*	*106.95, the area of lots 5, 6,and 7.*
Area of regular subdivisions	*=*	*360.00*
Total	*=*	*622.67, The area of Sec. 6.*

chs. chs.
Check: [77.87 + 77.75] x 4 = 622.48

77.75 x 0.025	*= 0.19,*	*the area of triangle C A B (fig. 6)*
Total	*= 622.67,*	*which agrees with the area of section 6,*

3. The area in acres of a tract 40.00 chains long, adjoining north or west township boundaries (except in N. W. 1/4 sec. 6), is equal to the sum of its parallel boundaries (expressed in chains and decimals thereof) multiplied by 2; (e. g.) the area of lots 6 and 7 (Plate I, fig. 6), is [17.87 + 17.81] x 2 = 71.36 acres.

The area in acres of a tract 60.00 chains long, situated as above described (excluding lot 4, of sec. 6), may be found by multiplying the sum of its parallel boundaries (expressed in chains

4 This means that 0.05 / 77.75 = q / 60

and decimals of a chain) by 3; (e. g.) fig. 6; south boundary lot 4 = 17.78 chs.; area of lots 5, 6, and 7 is [17.78 + 17.87] x 3 = 106.95 acres. (See example 2.)

The area in acres of quarter sections adjoining north and west township boundaries (excluding N. W. 1/4 sec. 6), may be obtained by multiplying the sum of their parallel boundaries (taken in chains and decimals of a chain), by 2; (e. g.) the area of S. W. 1/4 sec. 6 (fig. 6), is [37.87 + 37.81] x 2 = 151.36 acres.

The area in acres of any section along the north and west boundaries of regular townships (except sec. 6) may be had by multiplying the sum of its parallel boundaries (expressed in chains and decimals of a chain) by 4; (e. g.) the area of sec. 1 (Plate IV) is [80.00 + 79.77] x 4 = 639.08 acres.

The area in acres of a theoretical township may be obtained by multiplying the sum of its latitudinal boundaries (expressed in chains and

decimals of a chain) by 24; (e. g.) the area of the township represented by Plate I, fig. 1 is [480.00 + 479.34] x 24 = 23,024.16 acres.

vii. Parenthetical Distance Calculation in a Section 5

See Figure 58 on page 106.

In this case the factor, “d”, may be unnecessarily complicated. The same result for the parenthetical distance between lots 2 and 3 can be obtained by taking the mean of the two distances along the section lines.

The acreage calculation for Lot 1 illustrates two alternate methods. The method for calculating a square area is to multiply the mean of the north-south boundaries by the mean of the east-west boundaries and divide by 10. When a Lot is 20 chains wide in one cardinal direction the addition of the distances along the other cardinal direction results in the same answer.

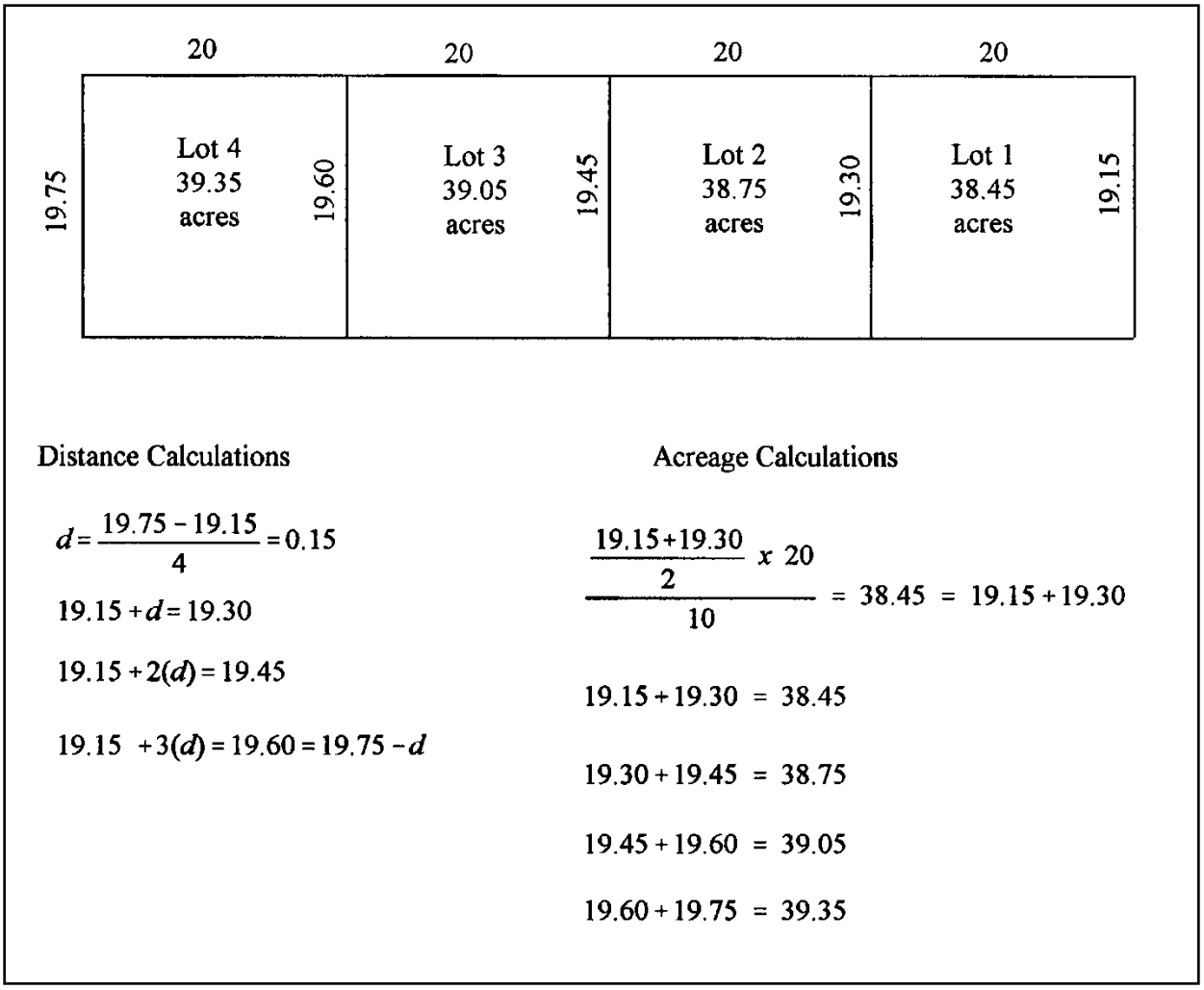
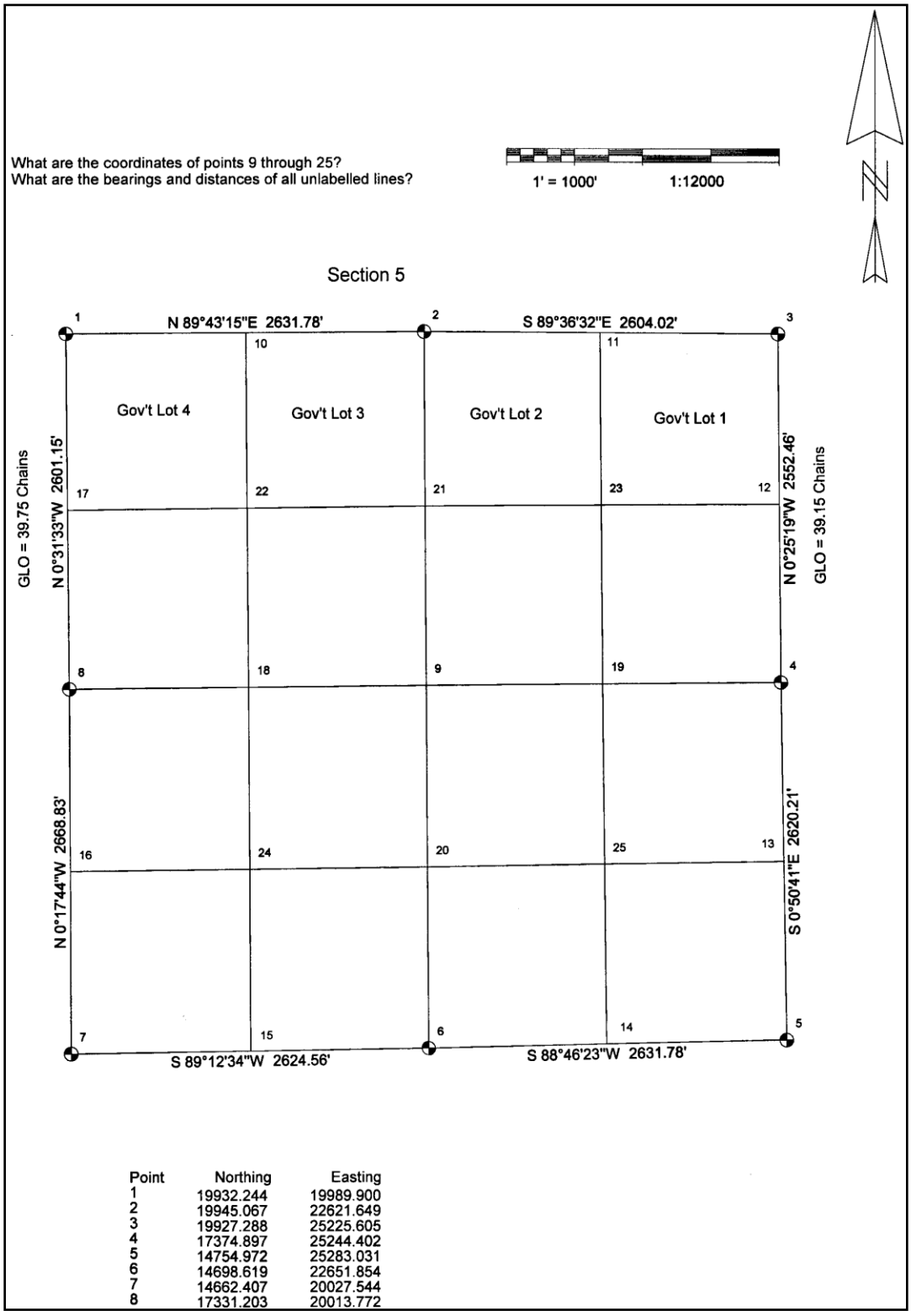


Figure 66

viii. Subdivision Exercise

Section 5 with Government Lots



Point	Northing	Easting
1	19932.244	19989.900
2	19945.067	22621.649
3	19927.288	25225.605
4	17374.897	25244.402
5	14754.972	25283.031
6	14698.619	22651.854
7	14662.407	20027.544
8	17331.203	20013.772

Figure 67

Section 5 Answers

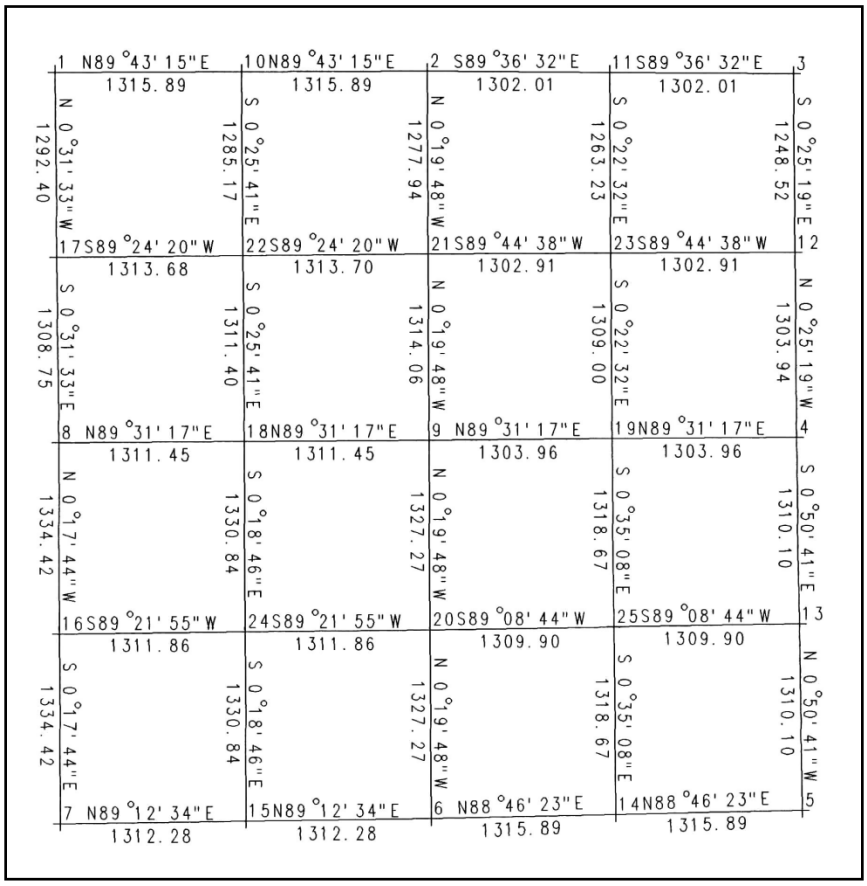


Figure 68

1	19932.2440	19989.9000	14	14726.7955	23967.4425
2	19945.0670	22621.6490	15	14680.5130	21339.6990
3	19927.2880	25225.6050	16	15996.8050	20020.6580
4	17374.8970	25244.4020	17	18639.8978	20001.7609
5	14754.9720	25283.0310	18	17342.1577	21325.1717
6	14698.6190	22651.8540	19	17364.0047	23940.4867
7	14662.4070	20027.5440	20	16025.8657	22644.2127
8	17331.2030	20013.7720	21	18667.1507	22629.0062
9	17353.1125	22636.5714	22	18653.5242	21315.3751
10	19938.6555	21305.7745	23	18672.9763	23931.9068
11	19936.1775	23923.6270	24	16011.3353	21332.4353
12	18678.8018	25234.7994	25	16045.4001	23953.9646
13	16064.9345	25263.7165			

ix. Parenthetical Distance Calculation in a Section 6

See Figure 58 on page 106.

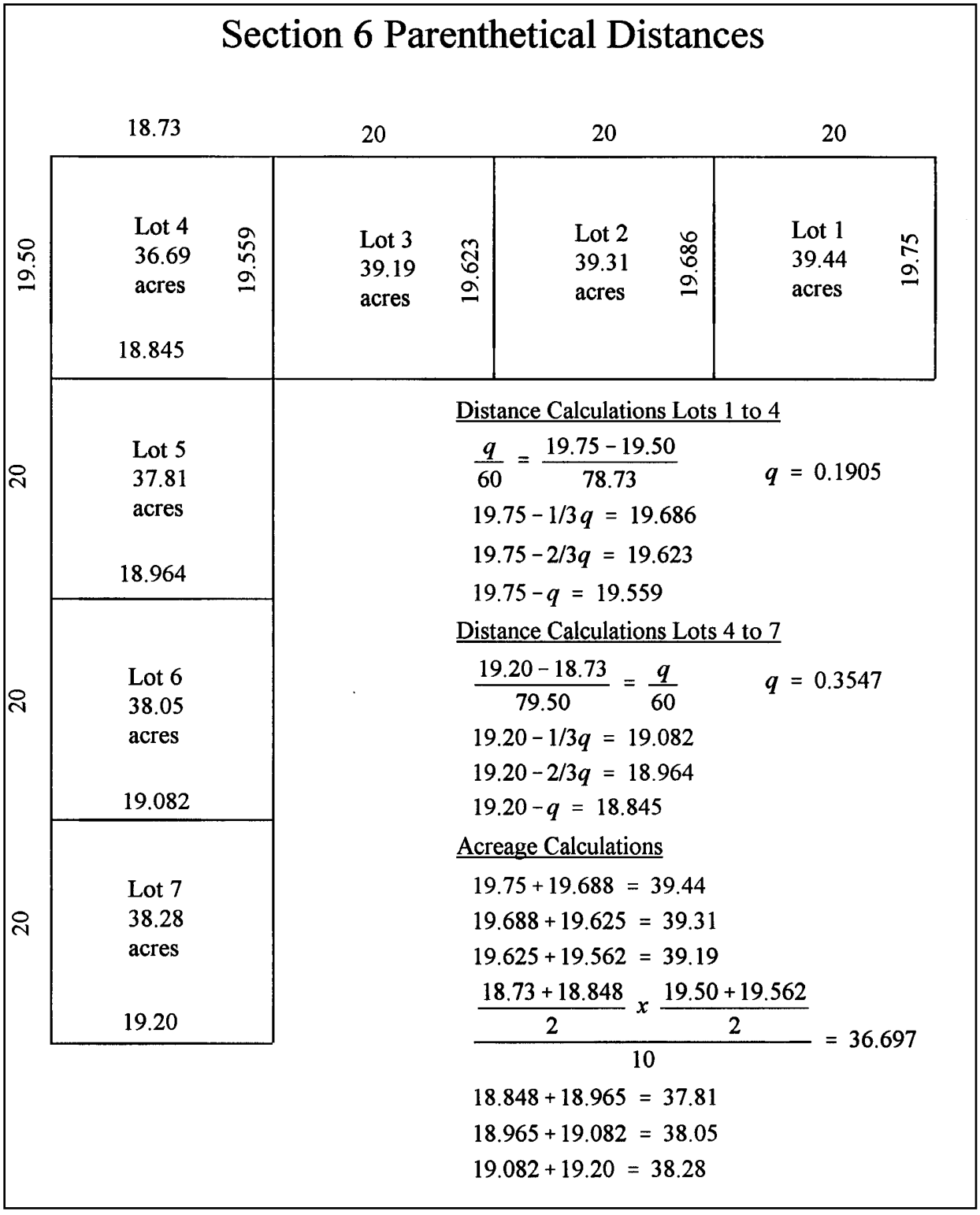


Figure 69

x. Two methods used for Section 6

The method explained in the 1894 manual for calculating parentheticals and acreages was not originally employed. In earlier surveys the fact that the centerline of the section may not be centered in the section was not considered. The parenthetical distance along centerline was calculated as the mean of the parentheticals along the section lines. Sometime in the 1880's the change was made to use the methodology of the 1894 manual.

GLO Plat T18N, R10W 1884

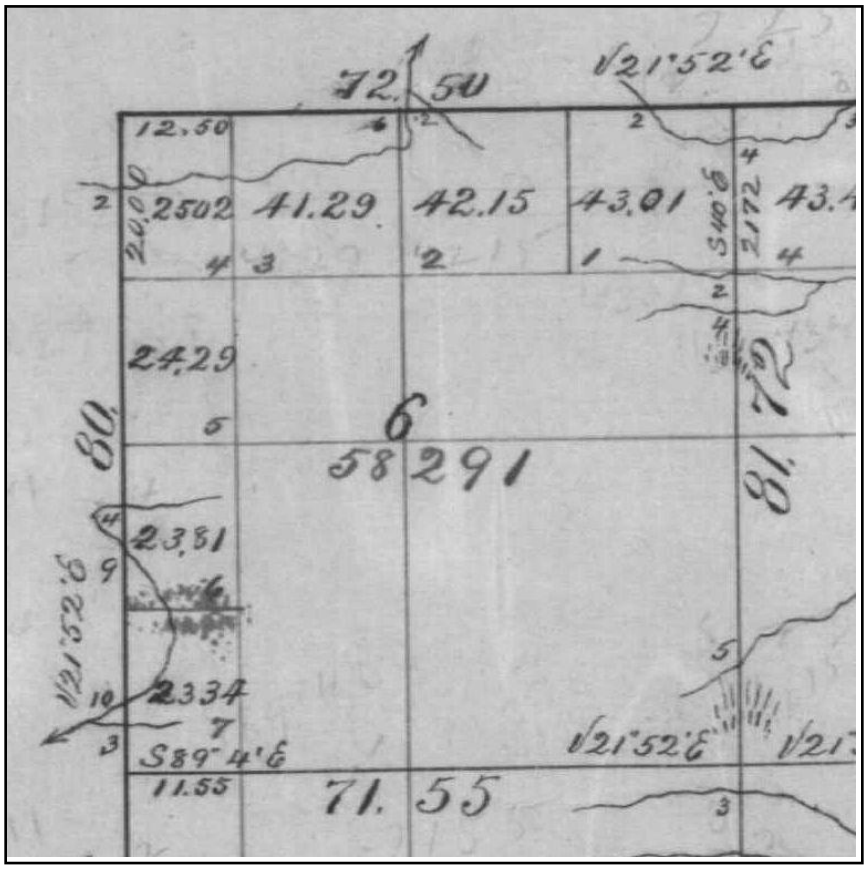


Figure 70

The following is not how the acreages were calculated in Figure 70 above.

q = (60/72.50) x 1.72 = 1.423
1/3 q = 0.474
Lot 1 = 21.72 + (21.72 - 1/3q) = 42.97
Lot 2 = (21.72 - 1/3q) + (21.72 - 2/3q) = 42.02
Lot 3 = (21.72 - 2/3q) + (21.72 - q) = 41.07
South line of lot 4 = 12.50 – (12.50-11.55) / 4 = 12.26
Lot 4 = (12.50+12.26) / 2 x (20 + 21.72 – q) / 2 /10 = 24.94

If the GLO plat is earlier than about 1885 then the method described in the 1894 Manual doesn't work and shouldn't be used to subdivide the section.

The following is how the acreages were actually calculated.

d = 1.72/4 = 0.430
Lot 1 = 21.72 + (21.72 - d) = 43.01
Lot 2 = (21.72 – d) + (21.72 - 2d) = 42.15
Lot 3 = (21.72 - 2d) + (21.72 - 3d) = 41.29
South line of lot 4 = 12.50 – (12.50-11.55) / 4 = 12.26
Lot 4 = (12.50+12.26) / 2 x (20 + 21.72 – 3d) /2 /10 = 25.026

GLO Plat T11N, R3E 1897

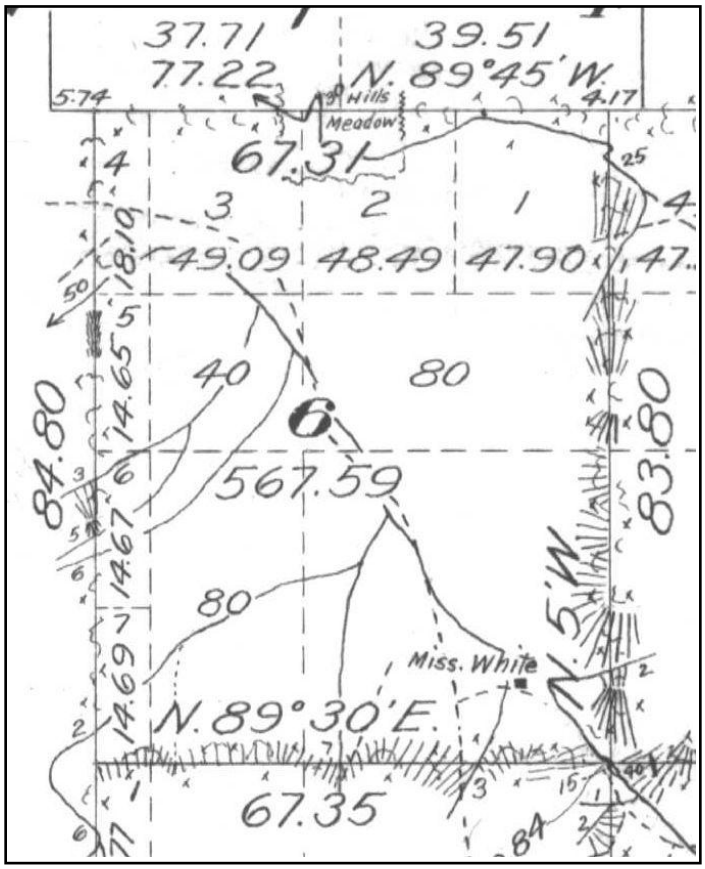


Figure 71

The acreages Figure 71 above were not calculated by the old method shown below.

d = (24.80 – 23.80)/4 = 0.250
Lot 1 = 23.80 + (23.80 + d) = 47.85
Lot 2 = (23.80 + d) + (23.80 + 2d) = 48.35
Lot 3 = (23.80 + 2d) + (23.80 + 3d) = 48.85
South line of lot 4 = 7.31 - (7.35 – 7.31)/4 = 7.32
Lot 4 = (7.31 + 7.32)/2 x (24.80 + 23.80 + 3d)/2 /10 = 18.05

Here the acreages were calculated using the method shown in the 1894 manual.

q = (60/67.31) x (24.80 – 23.80) = 0.891
1/3 q = 0.297
Lot 1 = 23.80 + (23.80 + 1/3q) = 47.90
Lot 2 = (23.80 + 1/3q) + (23.80 + 2/3q) = 48.49
Lot 3 = (23.80 + 2/3q) + (23.80 + q) = 49.09
South line of lot 4 = 7.31 - (7.35 – 7.31) x 60 / 84.80 = 7.32
Lot 4 = (7.31 + 7.32)/2 x (24.80 + 23.80 + q)/2 /10 = 18.10

xi. Elongated Sections

Elongated sections do not require special subdivision rules. There are more sixteenth corners but the rules about connecting opposite sixteenth corners to subdivide the section still apply.

GLO Plat, Section 1, T26N, R7E, W.M.

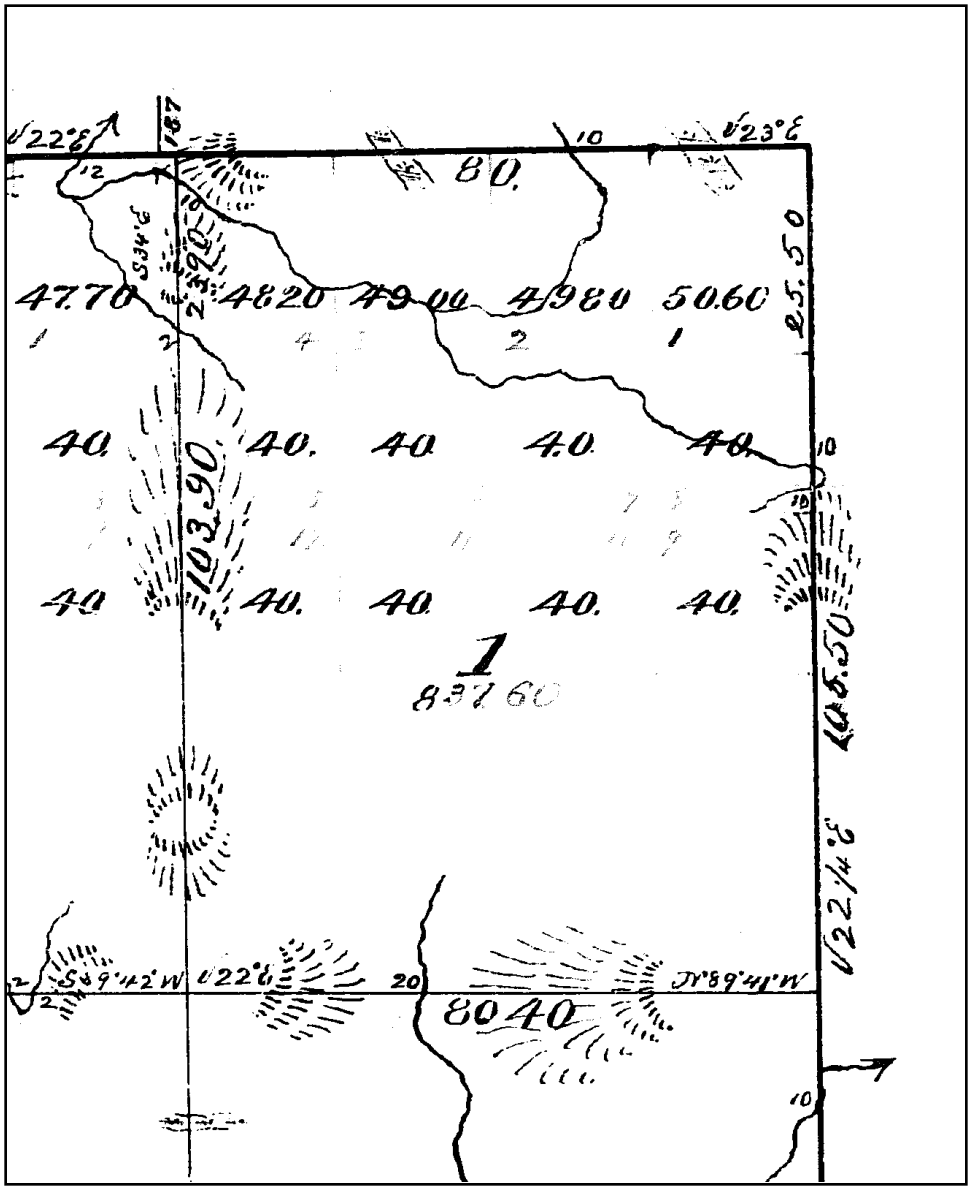


Figure 72

Survey of Section 1, T26N, R7E, W.M.

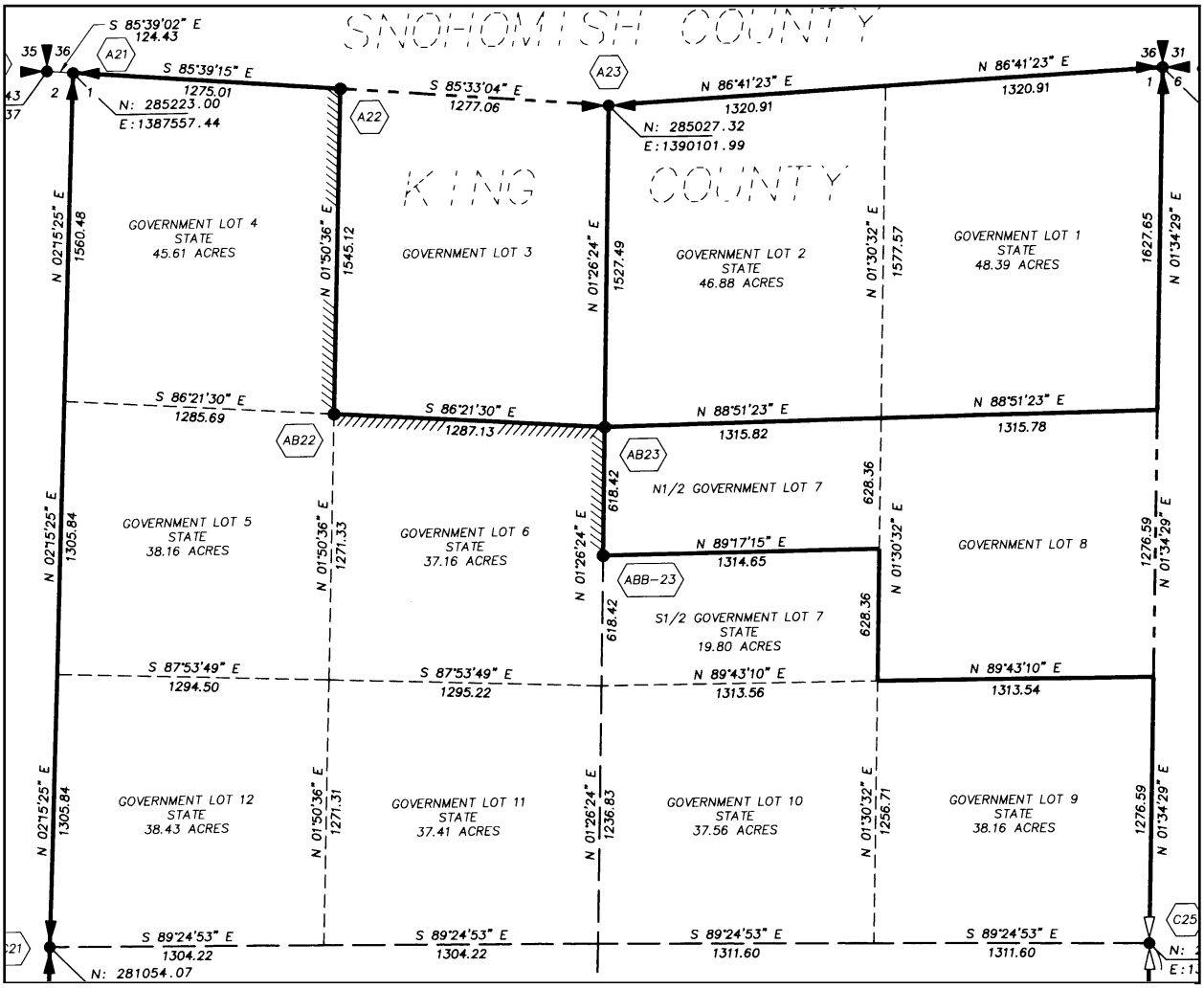


Figure 73

The distances between Lots 10 and 11 and between Lots 6 and 7 are 20 chains. The two methods for calculating the distance between Lots 2 and 3 are (a) to mean the east line of Lot 1 with the west line of Lot 4 and (b) to divide the sum of adjoining acreages by 4.

(a) (23.90 + 25.50) / 2 = 24.70

(b) (49.00 + 49.80) / 4 = 24.70

Calculate the distances along the north-south centerline.

4001.16 / (20 + 20 + 24.70) = 61.84173107 = scale

scale x 20 = 1236.83

scale x 10 = 618.42

scale x 24.70 = 1527.49

xii. Closing Sections with Closing Corners

Closing Corners effect how a closing section is subdivided.

If they are found off line, they are amended and a point is set on the true line. The original position of the closing corner effects the calculation of a 1/16 corner, and other subdivisional corners on the closing line.

5-41. Closing Corners (from the 1973 BLM Manual)

"A lost closing corner will be reestablished on the true line that was closed upon, and at the proper proportional interval between the nearest regular corners to the right and left.

A recovered closing corner not actually located on the line that was closed upon will determine the direction of the closing line, but not its legal terminus. The correct position is at the true point of intersection of the two lines.

When an original closing corner is recovered off the line closed upon and the new monument is established at the true point of intersection, the original position will control in the proportionate restoration of lost corners dependent upon the closing corner. ***In a like manner the positioning of sixteenth-section corner(s) or lot corner(s) on the closing line, between the quarter-section corner and the closing corner, will be based on the measurement to the original closing corner.****"*

Two methods for subdividing Closing Sections that have Closing Corners.

If a closing section closes into existing corners there is a single accepted method for section subdivision. But if there are closing corners and standard corners there a two current methods of subdivision. The two methods might be called “Subdivide first and then Truncate or Extend” and the “Truncate or Extend first and then Subdivide”. The theories are as follows.

Subdivide first and then Truncate or Extend:

- First, use the original closing corners to complete the section in theory. Ignore the existence of a senior or standard line and connect the original closing corners by a straight line and create a theoretical subdivision of the section.
- Second, truncate or extend the theoretical section to meet the senior or standard line.

Truncate or Extend first and then Subdivide:

- First, calculate the sixteenth and other proportioned corners on the closing section lines using original closing corners as control.
- Second, calculate the true closing corners on the senior or standard line.
- Third, calculate the quarter corner on the standard line and subdivide the rest of the section based on true corners on the senior or standard line. The center north 1/16 corner is proportioned to the true quarter corner on the standard line.

The difference between the two methods is most easily illustrated by closing corners that are far off the senior or standard line. The federal plat of section 3, Figure 74 below, shows four government lots along the north side, all of which are slightly larger than a normal quarter-quarter section.

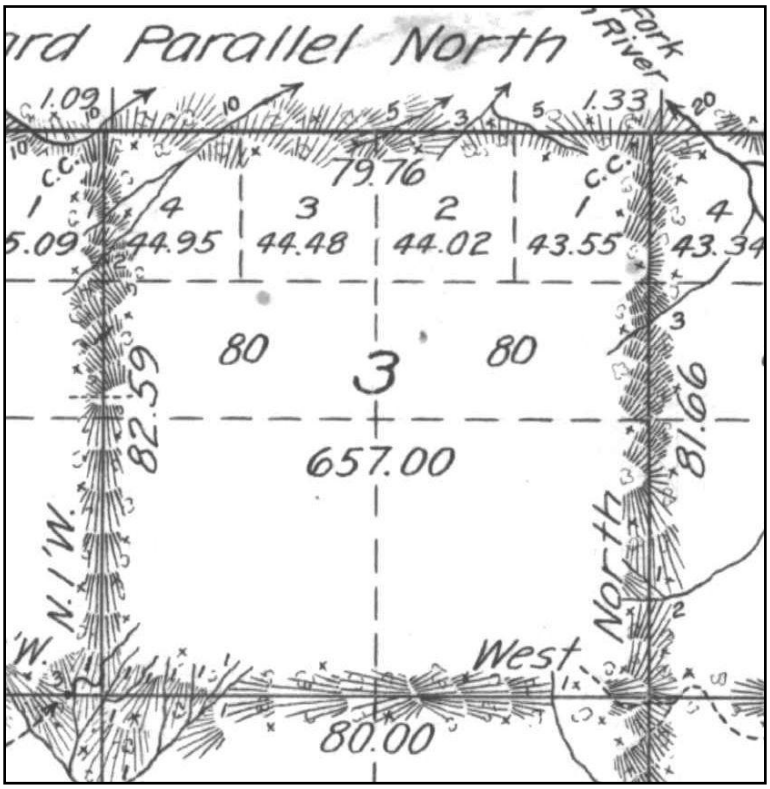


Figure 74

In Figure 75 below the subdivision employs the “Subdivide first and then Truncate or Extend Method”. The closing corners (the northerly triangles), which are found to be far north of the standard parallel, are first used to subdivide the section and then the section is truncated at the standard parallel. Note that because the closing corners are far into the township to the north the government lots on the north side of the section are much smaller than they appear on the original federal plat.

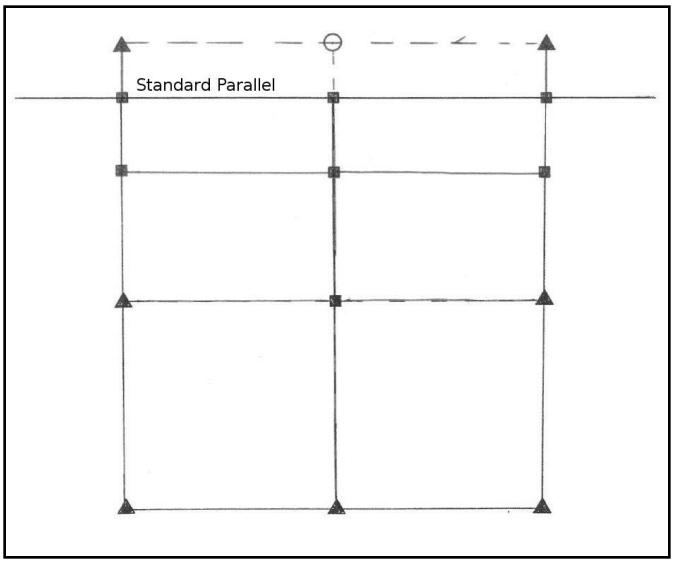


Figure 75

In Figure 76 the subdivision employs the “Truncate or Extend first and then Subdivide Method”. The closing corners (the northerly triangles), which are found to be far north of the standard parallel, are first used to calculate the sixteenth corners on the section line. Then the true closing corners and quarter corner on the standard parallel are calculated and used to subdivide the rest of section. Note that because the closing corners are far into the township to the north the government lots are distorted because along the section lines the original closing corners were used to proportion lot corners, but along the north-south centerline of the section, the quarter corner along the township line was used to proportion lot corners.

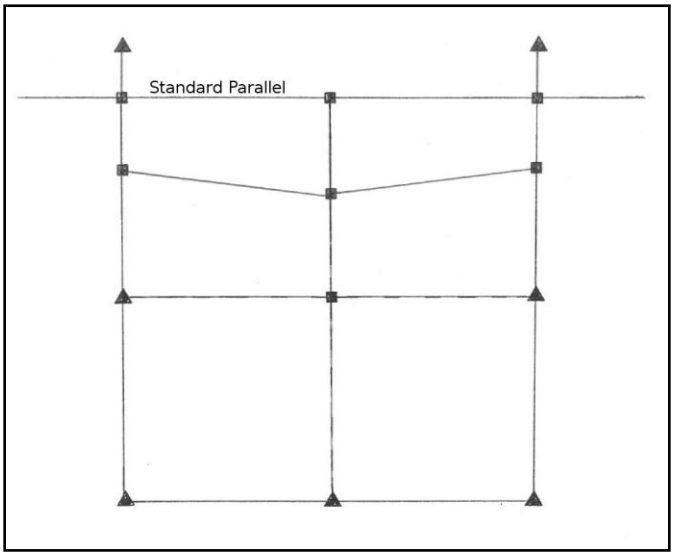


Figure 76

Closing sections to the south of a Standard Parallel normally will not have north 1/4 corners that were set by the GLO. The local surveyor must establish the North 1/4 corner and the Center North 1/16 corner. The previous page illustrates two methods that have been used to calculate those corners. The letters on the following pages are opinions of the Oregon office of the BLM. The 1/4 corner is to be set at a proportionate point longitudinally between the true points for the closing corners, not between the original closing corners, and at a point latitudinally on the true standard parallel. The C-N 1/16 corner is set at a proportionate position between the North 1/4, as established on the standard parallel and the Center 1/4 corner.

In other words, the Oregon State Office of the BLM currently employs the “Truncate or Extend then Subdivide Method”.

Note that it is entirely possible that in some circumstances the Oregon State Office of the BLM could advise otherwise.

Letter explaining how to calculate a quarter corner not set by the GLO

IN REPLY REFER TO:

United States Department of the Interior

9600 (942)

BUREAU OF LAND MANAGEMENT

OREGON STATE OFFICE
P.O. Box 2965 (825 NE Multnomah Street)
Portland, Oregon 97208

January 7, 1988

Michael P. DeMers
Professional Land Surveyor
Forest Property Consulting Service
Route 1 160 Hennepin
Okanogan, Washington 98840

Dear Mr. DeMers:

This is in response to your letter of December 20, 1987, concerning a survey you are doing in T. 37 N., R. 26 E., Willamette Meridian, Washington.

Our records indicate that the ¼ section corner on the north boundary of section 6 was never established. This office would establish this corner latitudinally on the south boundary of section 31, and at a proportionate longitudinal position between the true point for the closing corner of sections 5 and 6 and the township corner to the west.

That portion of the Manual's section 5-41 pertaining to how the original closing corner controls proportioning means corners reestablished on the closing line and not the line closed upon.

We hope this information is helpful.

Sincerely,

Daniel L. Berry

Daniel L. Berry
Acting Chief, Branch of Cadastral Survey

Letter explaining general rules for subdividing sections closing on a standard parallel

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
OREGON STATE OFFICE
P.O. BOX 2965 (825 NE MULTNOMAH STREET)
PORTLAND, OREGON 97208

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

9626 (942)

September 20, 1988

Mr. Frank Fischer, Regional Surveyor
Washington State Dept. of Natural Resources
Northeast Area Office
225 S. Silke Road, P.O. Box 190
Colville, WA 99114

Dear Mr. Fischer:

This is in reply to your letter, dated September 8, 1988, in which you have inquired about procedures for establishing a ¼ section corner on a standard parallel between closing corners, and establishing a center N 1/16 section corner based on such a ¼ corner during section subdivision.

You have asked what the rules are for these situations. In response to this question, we do not believe there are any official rules or legal opinions on this subject. Sections 5-35(2) and 5-41 of the 1973 Manual provide guidelines for treating closing corners, but do not specifically address the subject of your inquiry. That which follows is the procedural policy of this office, based on Manual interpretations, and the principles of honoring the intent of the original plat and protecting the bona fide rights acquired with patents based on that plat. It is our understanding that this same policy is followed throughout the Bureau.

Given the situation you have presented, this office would first determine the true intersection points of the closing lines with the standard parallel (true points for the closing corners). The ¼ section corner on the north boundary of a section south of the standard would then be established at midpoint or proportionate distance longitudinally between the true points for the closing corners, and latitudinally on the standard parallel as defined by the nearest standard corners on either side. The center N 1/16 section corner for the section to the south would then be established at a proportionate position, based on the section lotting, between the center ¼ and the above established ¼ section corner on the standard.

The basic rationale for using these procedures follow:

1. The legal terminus for a closing line is at the intersection with the line closed upon (standard parallel in this case). The areas calculated for lots 1 through 4 of a section to the south were determined based on physical measurements along the closing lines to

the intended intersection with the standard, where closing corners were set. The bona fide rights acquired with any patents to lots 1 through 4 were meant to extend to the standard parallel as defined by the standard corners, not the original closing corners.

2. Closing corners were established in the course of measuring a closing line on which other corners were physically set or protracted (¼ and N 1/16 corners in this case). As prescribed by Section 5-41 of the Manual, a found original closing corner must control the establishment or reestablishment of corners dependent on its position, i.e., corners along the closing line. This principle however has no effect on the concept that the legal terminus of this line, and the northerly limit of lots 1 through 4, is defined by the standard parallel, regardless of the actual position of the original closing corners.

3. Section 5-35(2) of the Manual states, ". . . . the corners first established control both the alignment and the proportional measurement along the line." We interpret this to mean that the corners (standard corners, etc.) controlling the line closed upon, being first set, control the distance for a ¼ section corner on the north boundary of a section to the south, even though this corner wasn't originally monumented.

4. Using the true intersection point for a recovered closing corner is consistent with the procedure that would be used if the original closing corner was lost.

With respect to a center N 1/16 section corner, the true points for the closing corners are the northeast and northwest corners of the section to the south, which in turn control the longitudinal length of the north boundary of lots 1 through 4. Inasmuch as the original intent was to have the north terminus of the north and south center line (north ¼ corner) on the standard parallel and this point was never monumented, it is followed by the BLM that this point should be controlled longitudinally by the true intersection points of the closing corners. This point would then control a center N 1/16 section corner to the south.

We hope this information helps explain the BLM policy on this subject.

Sincerely,

Wayne M. Gardner

Wayne M. Gardner
Chief, Branch of Cadastral Survey

A Closing Section against an Irregular Range Line
GLO Plat of Section 13, T6N, R3E, W.M.

The challenge is to find the parenthetical distance along the east-west centerline between the CE 1/16 corner and the east quarter corner.

The calculations on the following page produce acreages that fit the GLO plat. The methodology was found among GLO calculation sheets at the Oregon State Office of the BLM in Portland.

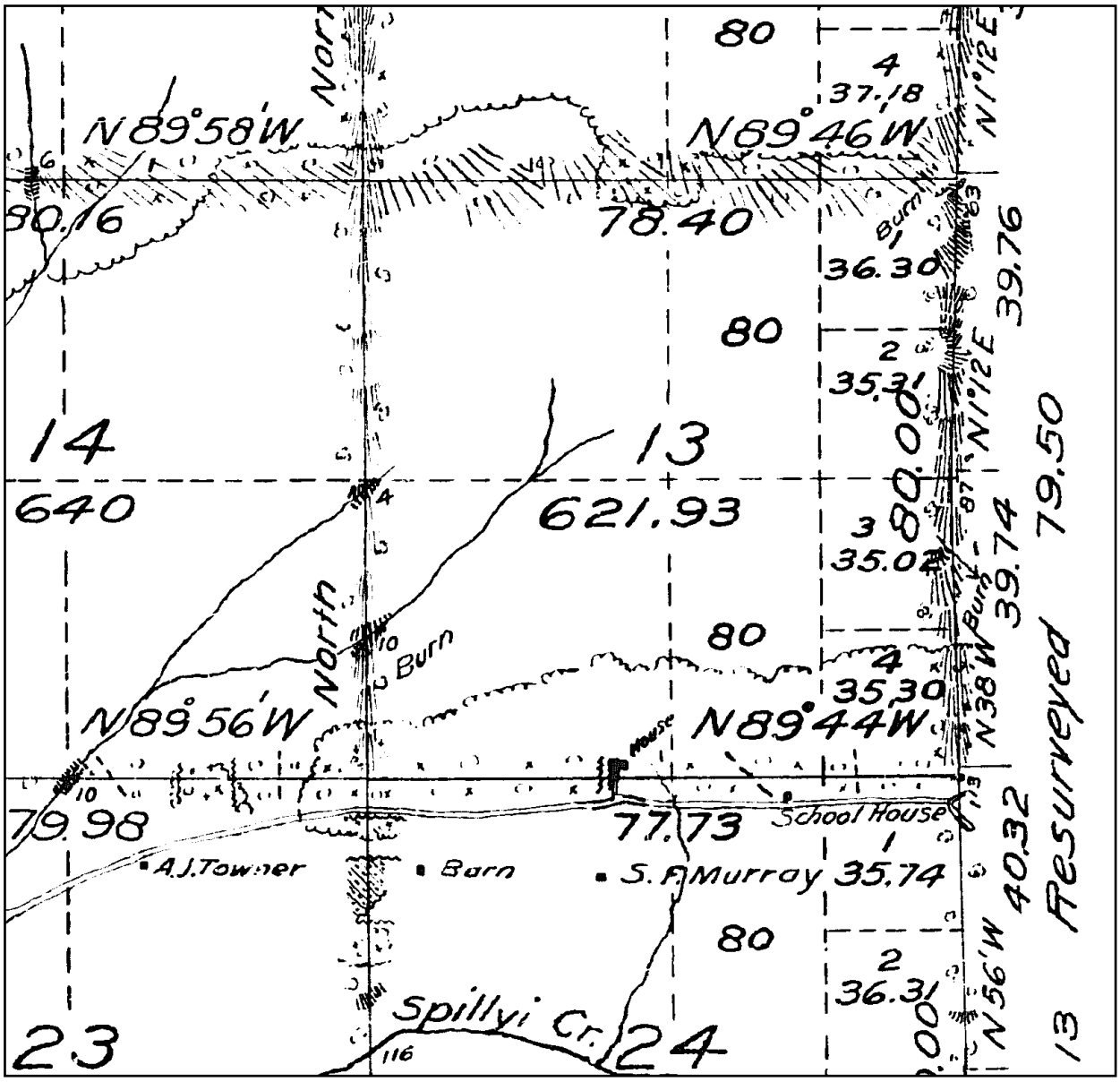


Figure 77

Calculate Parenthetical Distances, Section 13, T6N, R3E, W.M.

Adjust out the misclosure in easting.

Tangent of bearing times northing = departure

tan (-56') x 1.13	= -0.016291181 x 1.13	= -0.018409034
tan (-38') x 18.87	= -0.011054202 x 18.87	= -0.208592795
tan (-38') x 20.00	= -0.011054202 x 20.00	= -0.221084043
tan (-38') x 0.87	= -0.011054202 x 0.87	= -0.009617156
tan (+1°12') x 19.13	= +0.020947014 x 19.13	= +0.400716376
tan (+1°12') x 20.00	= +0.020947014 x 20.00	= +0.418940278
	total	= +0.361953627

South Boundary of Lot 4 = 17.73
Computed total departures = +0.36195363
Computed North Boundary of Lot 1 = 18.09195363
Actual North Boundary of Lot 1 = 18.40
Misclosure in easting = +0.308046370

Misclosure / Northing = Tangent of Angle of Misclosure in easting
+0.308046370 / 80.00 = 0.003850580

Adjust Course Tangents.

Azimuth	Orig. Tan	Adjustment	Adjusted Tangent
-56'	-0.016291181	+0.003850580	-0.012440601
-38'	-0.011054202	+0.003850580	-0.007203623
+1°12'	+0.020947014	+0.003850580	+0.024797594

Adjusted Tangent	x Distance	= Adjusted Departure
-0.012440601	x 1.13	= -0.014057879
-0.007203623	x 18.87	= -0.135932359
-0.007203623	x 20.00	= -0.144072453
-0.007203623	x 0.87	= -0.006267152
+0.024797594	x 19.13	= +0.474377962
+0.024797594	x 20.00	= +0.495951868

Compute parentheticals south to north.

17.73 south boundary lot 4
-0.014 = 17.716 at angle point
-0.136 = 17.580 between lots 3 and 4
-0.144 = 17.436 between lots 2 and 3 <-- this is the one we need
-0.006 = 17.430 at angle point
+0.474 = 17.904 between lots 1 and 2
+0.496 = 18.400 north boundary of lot 1, check

Compute lot acreages south to north.
Lot 4 (1st part) = (((17.73 + 17.716) / 2) x 1.13) / 10 = 2.003
Lot 4 (2nd part) = (((17.716 + 17.580) / 2) x 18.87) / 10 = 33.302
Lot 4 (total) = 2.003 + 33.302 = 35.305 (record = 35.30)
Lot 3 = 17.580 + 17.436 = 35.016 (record = 35.02)
Lot 2 (1st part) = (((17.436 + 17.430) / 2) x 0.87) / 10 = 1.517
Lot 2 (2nd part) = (((17.430 + 17.904) / 2) x 19.13) / 10 = 33.797
Lot 2 (total) = 1.517 + 33.797 = 35.314 (record = 35.31)
Lot 1 = 17.904 + 18.400 = 36.304 (record = 36.30)

5. Subdivision of Fractional Sections

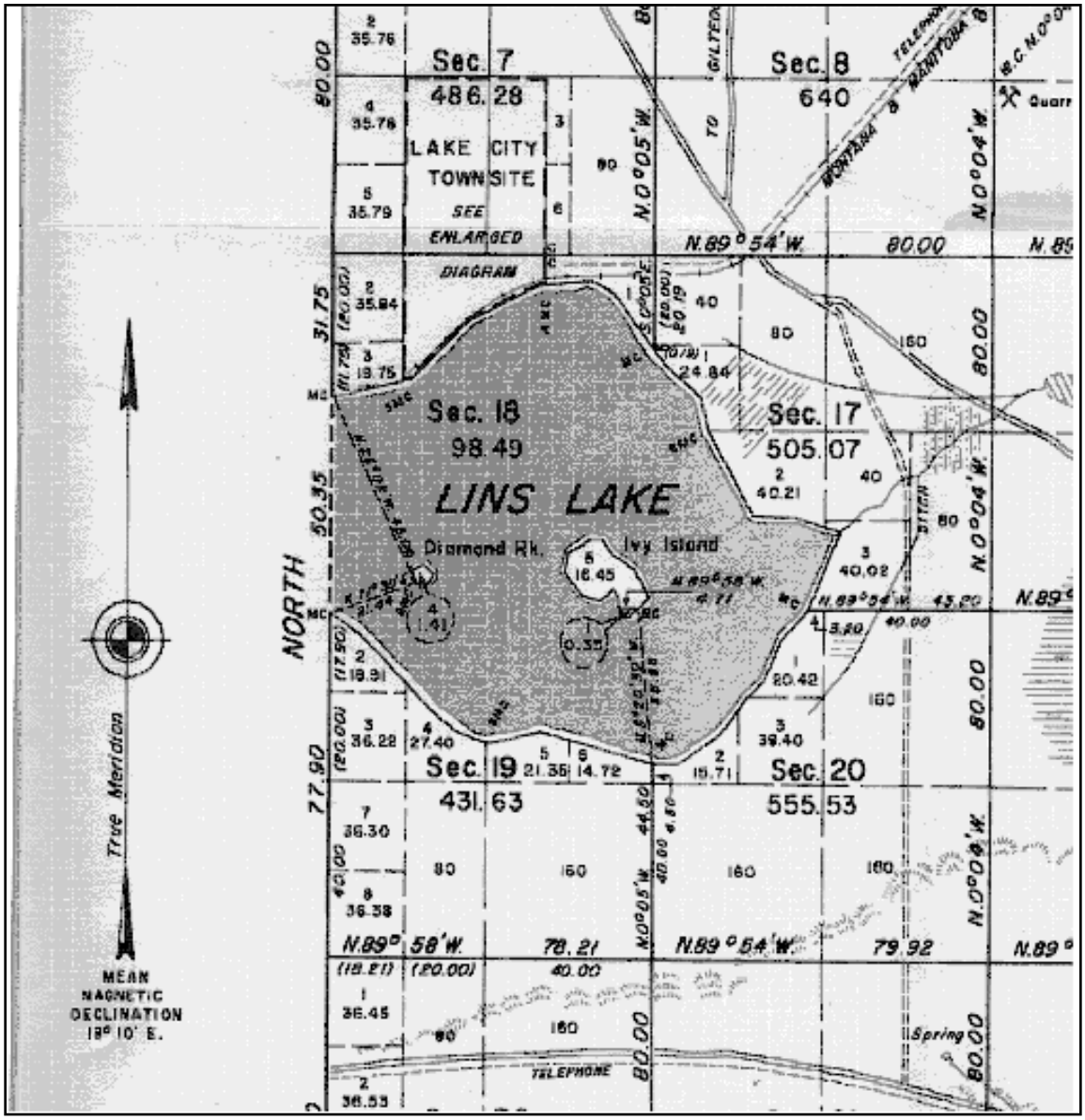


Figure 78

i. Definition of a Fractional Section

FRACTIONAL TOWNSHIP

As defined in the BLM Glossary

"A township containing less than 36 normal sections, usually because of invasion by a segregated body of water, or by other land which cannot properly be surveyed as part of that township or by closing the public-land surveys on State boundaries or other limiting lines. Half ranges and half townships are fractional townships by definition."

FRACTIONAL SECTION

As defined in the BLM Glossary

"A section, which in its original form, contained one or more subdivisions of less than forty (40) acres due to irregular exterior boundaries, or due to the encroachment of a meandered body of water or other land which could not properly be surveyed or disposed of as an aliquot part of that section."

The Act of February 11, 1805 has a tacit definition of a fractional township:

"But in those portions of the fractional townships, where no such opposite corresponding corners have been or can be fixed, the said boundary lines shall be ascertained, by running from the established corners, due north and south, or east and west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional township."

According to the act a section is made fractional by water, by Indian boundaries, or by some other external boundary. Closing into a township or range line is not mentioned.

The Acts of April 25, 1820, and of April 5, 1832, extend the procedures of the Act of February 11, 1805, to include subdivision of sections as well as subdivision of townships.

In 1826, George Graham, Commissioner of the GLO, wrote to George Davis at Washington, Mississippi, concerning fractional sections and subdivisions of them. The following is extracted from that letter.

> *It is here proper to premise that the technical meaning of a "fractional section" is a tract of land not bounded by sectional lines on all sides, in consequence of the intervention of a navigable stream or some other boundary recognized by law, and containing a less quantity than six hundred & forty acres. Tracts of land bounded on all sides by sectional lines & containing a less quantity than six hundred & forty acres are not fractional sections known to the law, & therefore are not to be treated as such.*

In 1831, Gideon Fitz, in his "Instructions for Surveying the Lands of the United States, in the State of Mississippi" talks about what makes townships and sections fractional. He clearly feels that closing sections are not "fractional".

"Fractional Sections are occasioned by Indian boundaries, District boundaries, State boundaries, navigable water courses, and individual or private claims. On navigable water courses, the sections may retain their square form, and yet become fractional, because part of the area of such sections, are taken out by such water course; and the parts of such sections are separated, and may not be connected by their boundaries continuing on the same right line across such stream, nor is it necessary that the lines in such situations should be continued directly across such navigable streams, because the fractional part of such sections on opposite sides of such streams, have their areas determined independent of each other.

Fractional sections, in the meaning of the law, are not occasioned by the section containing more or less than 640 acres, but become fractional only in situations as above mentioned, on navigable water courses, Indian boundaries, district, or State boundaries, and by individual claims."

By the time of the surveys in the Oregon and Washington section lines were normally measured across meandered rivers and the section subdivision is not made independently for each side of the river, except in the case where the river marks the boundary of an Indian reservation and the township subdivisions were made independently on each side of the river.

Later GLO Manuals and Circulars sometimes refer to closing sections as being fractional. However, the difference between closing sections and sections made fractional by water or some other survey is always maintained.

New Definition of a Fractional Section

- An Irregular Section is a section having one or more boundaries exceeding the rectangular limits, or containing one or more lots, or is not a regular section.
- Invaded Section – an irregular section invaded by a meanderable body of water or by approved claim, grant, or reservation at variance with the regular legal subdivisions;
- Fractional Section – an invaded section in which by the field notes no such opposite corresponding corners have been or can be fixed for at least one subdivision of section line;

  (Bob Dahl, Memo dated December 19, 2006)

Definition of a Fixed Corner:

For the purposes of the statute, a corner is fixed by the field surveyor by either setting a monument, or, by measurement and reference. The corners fixed are reported by the field surveyor in the draft returns, the field notes and sketch plat. The field notes are approved by the cadastral chief and become official upon the official filing of the plat.
(Bob Dahl, Memo dated December 19, 2006)

The Act of February 11, 1805 instructs how to subdivide Fractional Sections where opposite corners are not fixed:

"But in those portions of the fractional townships, where no such opposite corresponding corners have been or can be fixed, the said boundary lines shall be ascertained, by running from the established corners, due north and south, or east and west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional township."

ii. Situations that make Sections Fractional

1. A Reservation or Grant
2. A Meandered Body of Water
3. A Patented Tract
4. An Uncompleted Survey

A Reservation

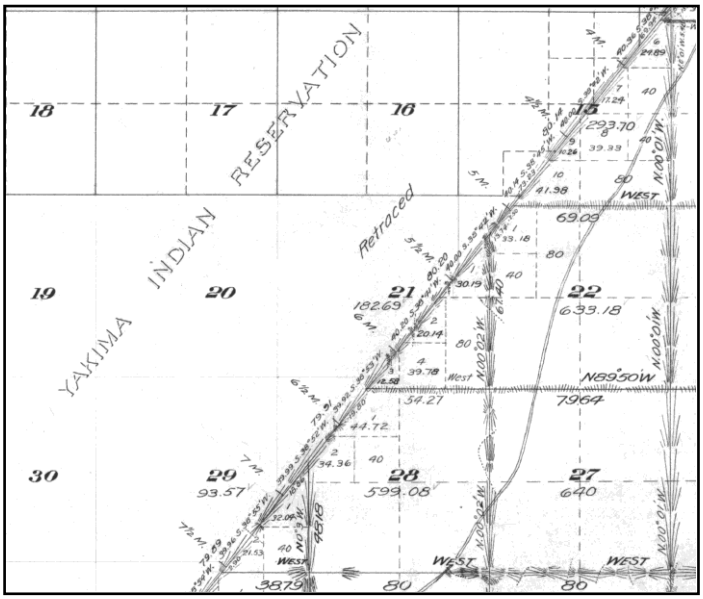


Figure 79

A Meandered Body of Water

Note that the section lines are measured across the river and the section, though fractional, was surveyed as a whole with all of the exterior lines measured in their entirety.

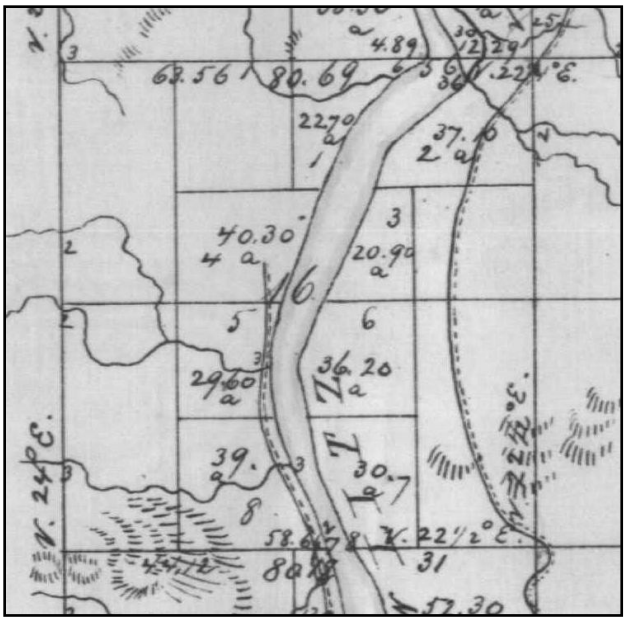


Figure 80

Not a Fractional Section – Not Meandered

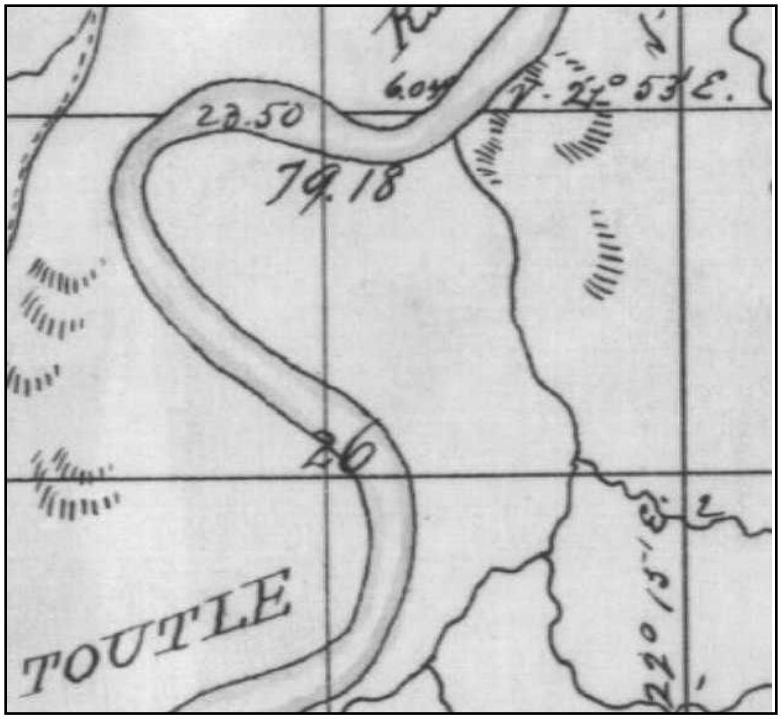


Figure 81

A Meandered Body of Water

Here each side of the river was surveyed independently and both fractional parts of section 25 must be subdivided independently. See Figure 82 and Figure 83.

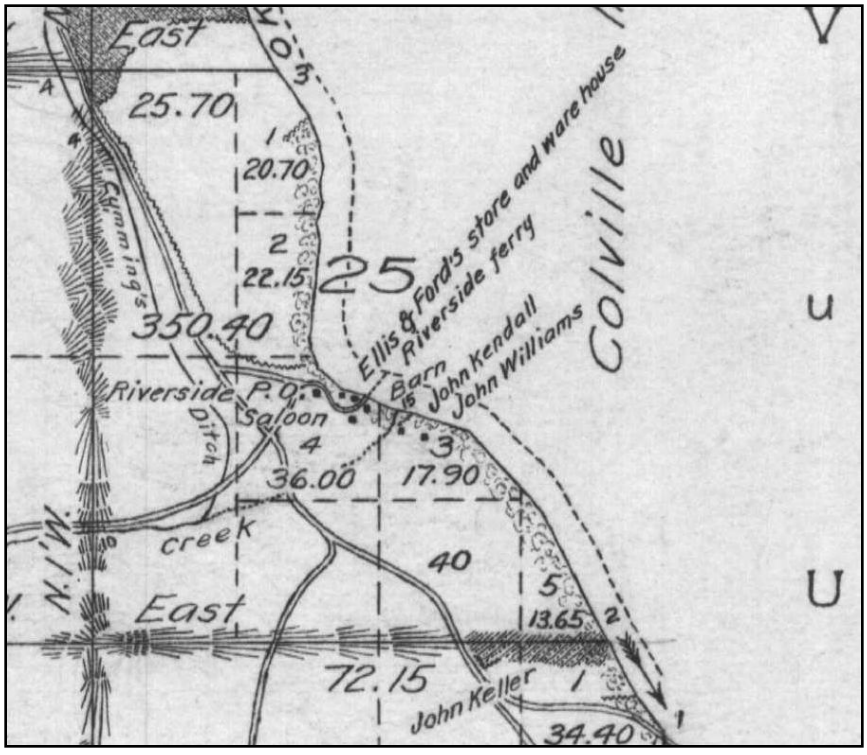


Figure 82

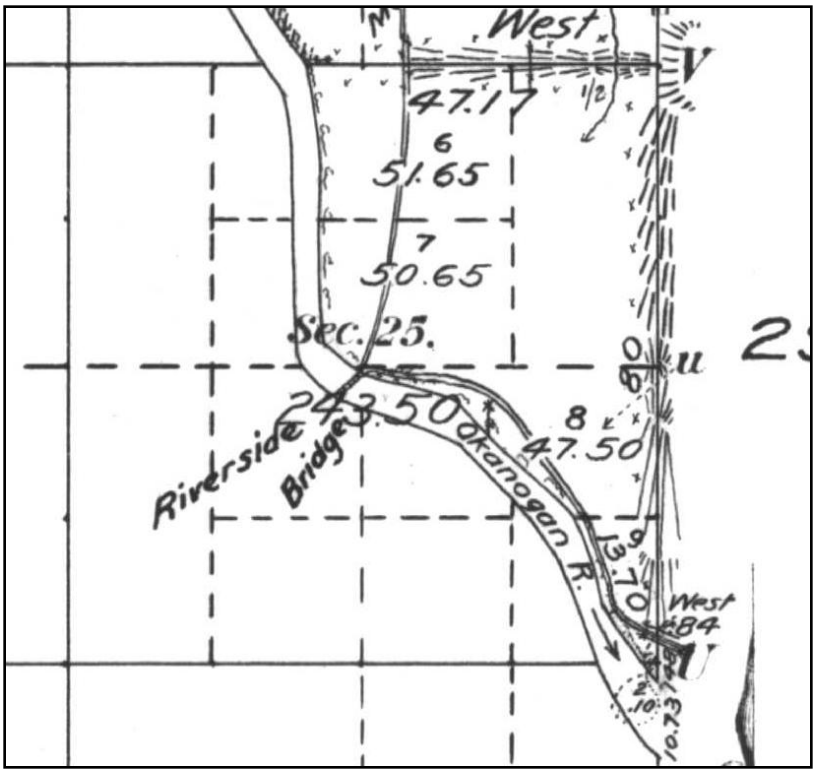


Figure 83

A Big Meandered Body of Water
The Pacific Ocean

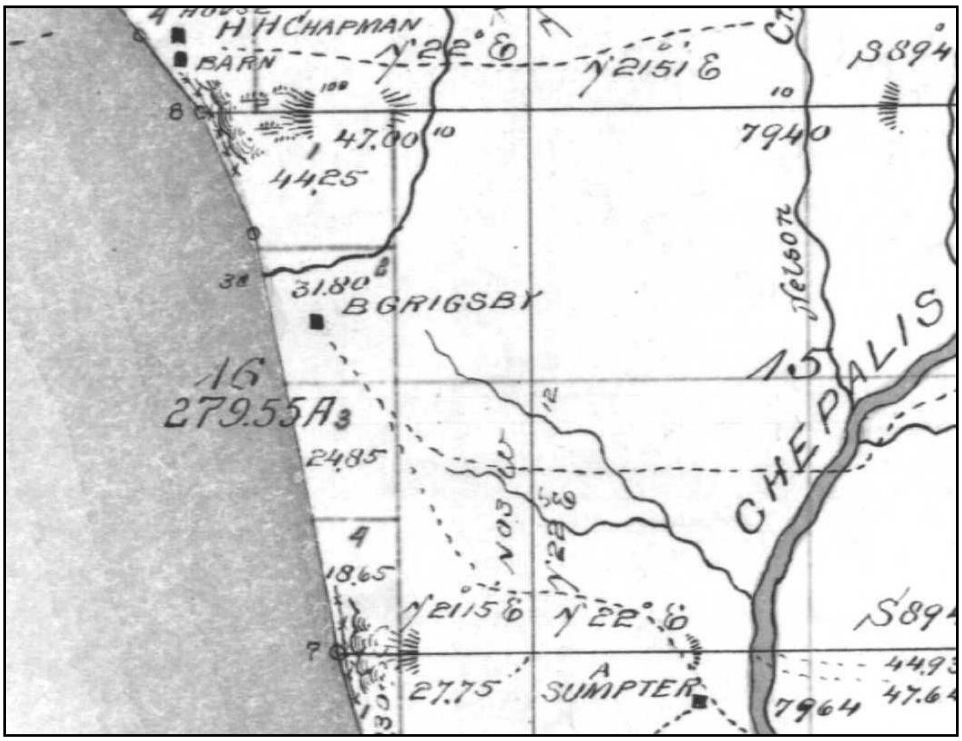


Figure 84

Patented Tracts

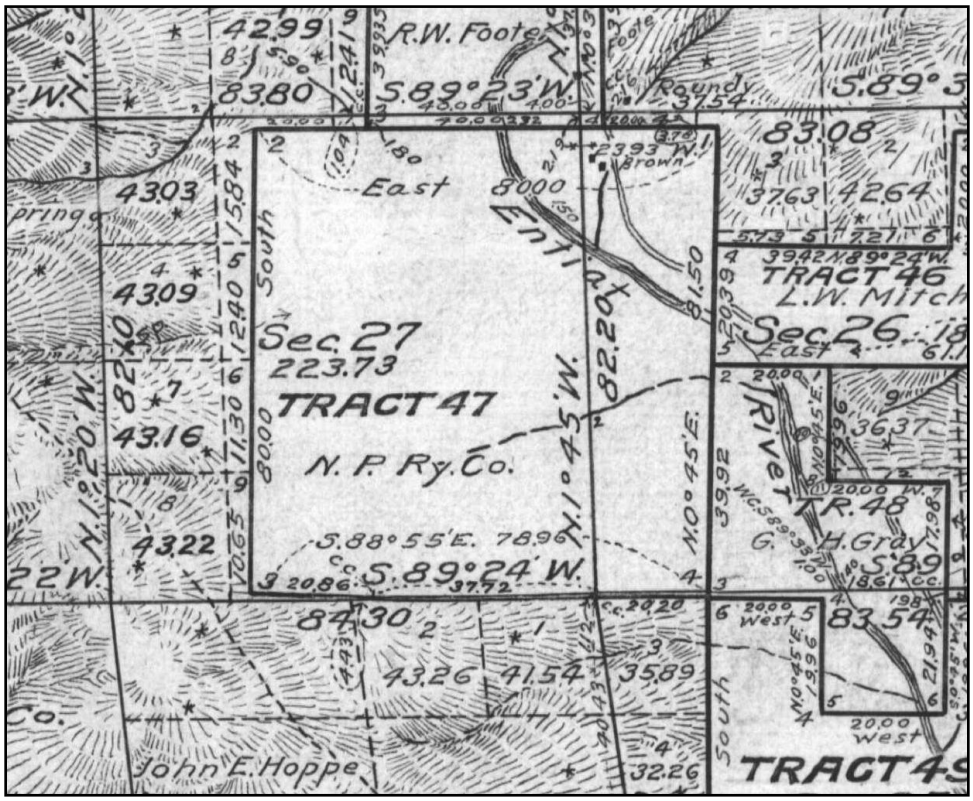


Figure 85

Donation Land Claims

The sections were surveyed as a whole and then the DLC's were cut out, providing corners to use for subdividing the sections and reducing the need to employ mean or parallel bearings to subdivide fractional sections created by DLC's. See Figure 86 and Figure 87 below.

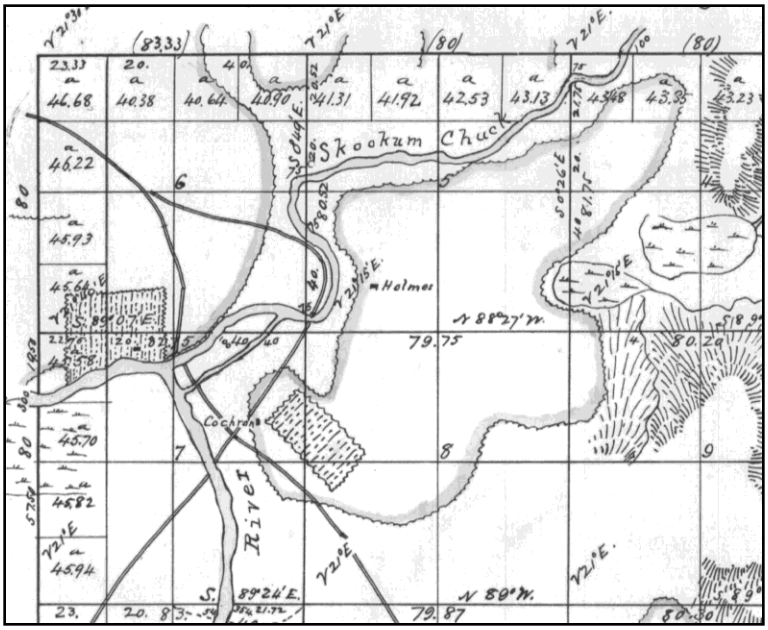


Figure 86

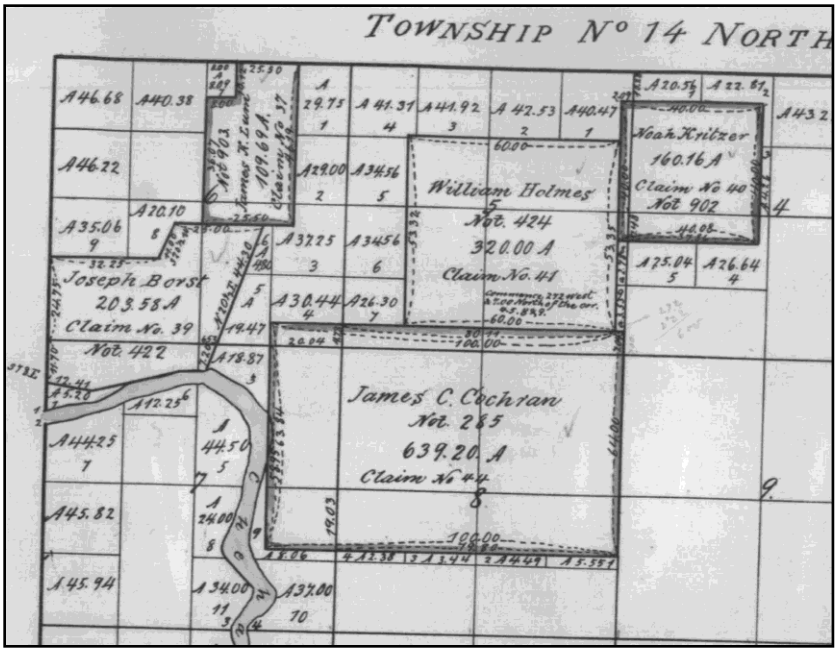


Figure 87

An Uncompleted Survey

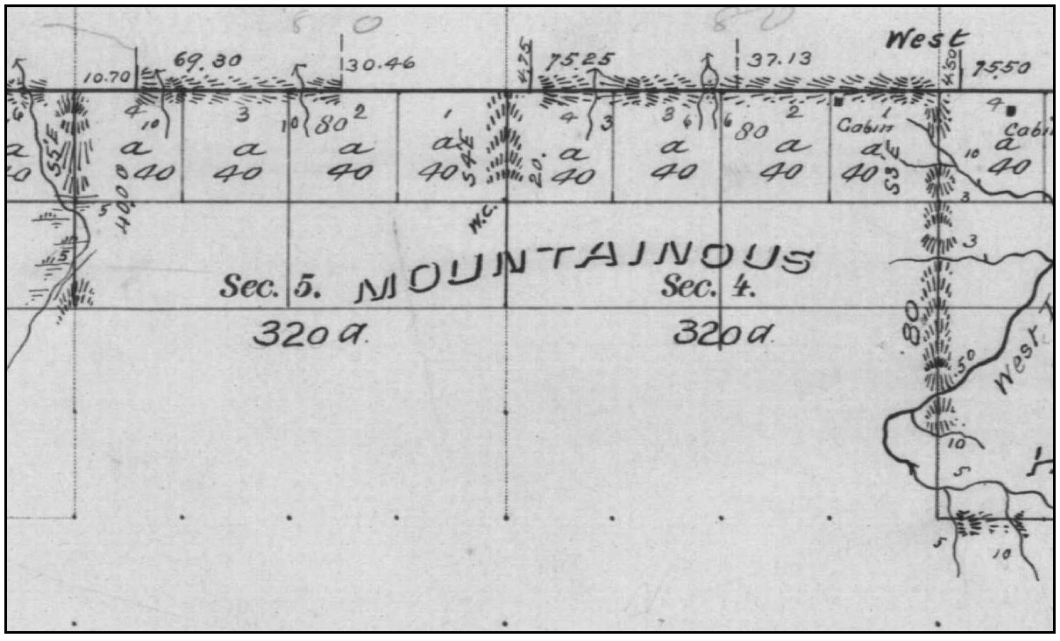


Figure 88

iii. Subdivision of Fractional Sections

From the BLM manual:

3-88. *The law provides that where opposite corresponding quarter-section corners have not been or cannot be fixed, the subdivision of section lines shall be ascertained by running from the established corners north, south, east, or west, as the case may be, to the water course, reservation line, or other boundary of such fractional section, as represented upon the official plat.*

In this the law presumes that the section lines are due north and south, or east and west lines, but usually this is not the case. Hence, in order to carry out the spirit of the law, it will be necessary in running the center lines through fractional sections to adopt mean courses where the section lines are not on due cardinal, or to run parallel to the east, south, west, or north boundary of the section, as conditions may require, where there is no opposite section line.

Where opposite section lines do not exist
section centerlines are parallel to the section lines.

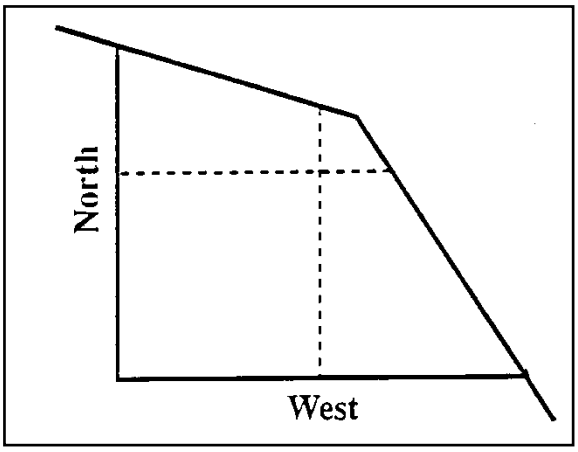


Figure 89

Subdivisions where one of the quarter section corners does not exist.
The corresponding subdivision line will be run on a mean course.

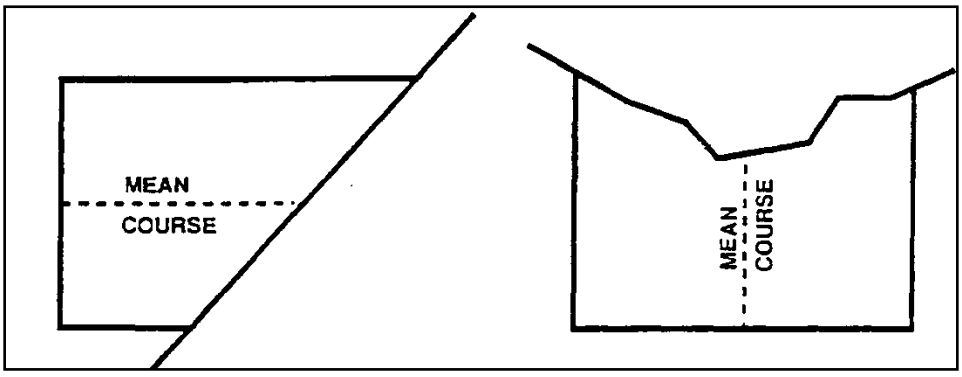


Figure 90

Where two adjacent quarter section corners do not exist,
but portions of all exteriors exist, mean courses will be adopted.

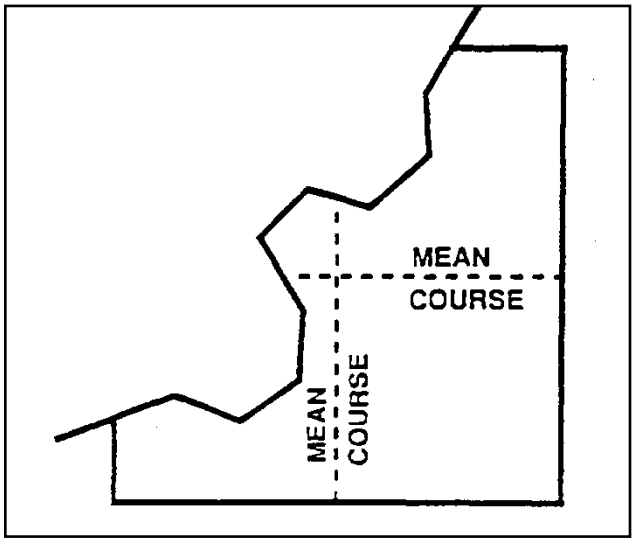


Figure 91

Arithmetic Mean is a mean of the sums of opposite section lines.
This method was used at times in the past but is not the accepted method at present.

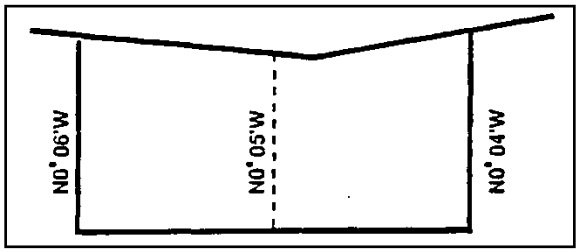


Figure 92

Weighted Mean
Opposite section lines differing greatly in length mean is developed in ratio to the lengths of opposite section lines. The is the currently accepted method.

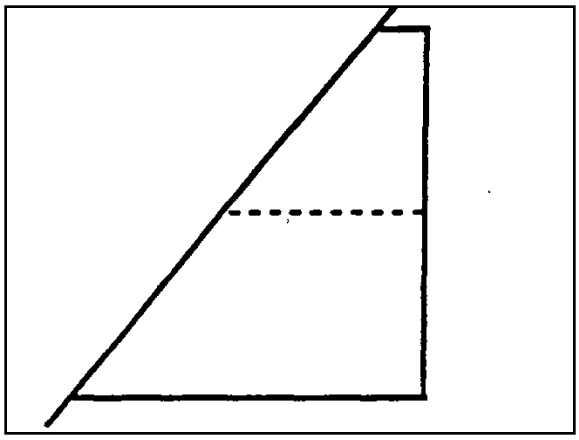


Figure 93

Subdivisions involving non-existent quarter section corners where there are no opposite section lines can occur

- **Against fixed and limiting boundaries**
- **Against meanderable water courses**
- **Where surveys are incomplete**
- **Generally, parallel lines will be adopted in running subdivision lines.**

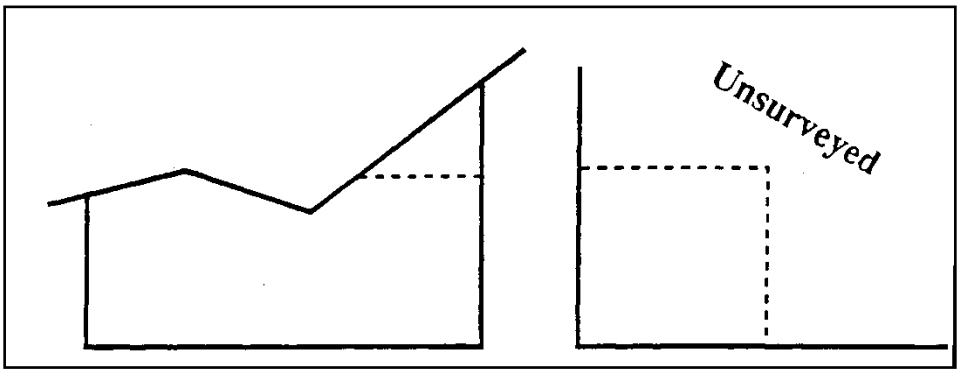


Figure 94

**When you run parallel to a section line,
the bearing is the mean bearing of the section line,
which is the same as the inverse between the corners
at the ends of the section line.**

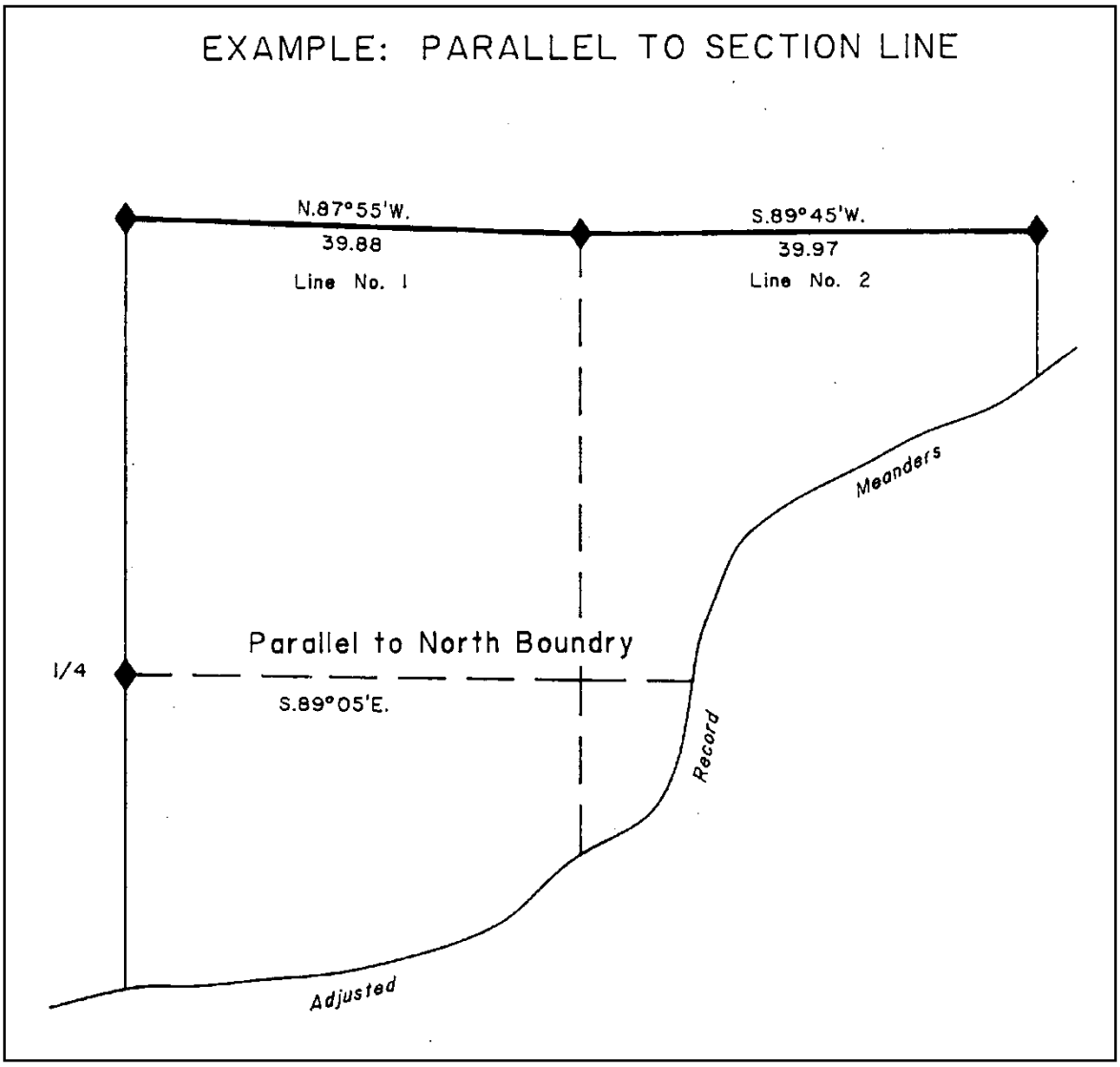


Figure 95

A weighted mean bearing is most easily computed by an inverse of all the courses of the two opposite section lines.

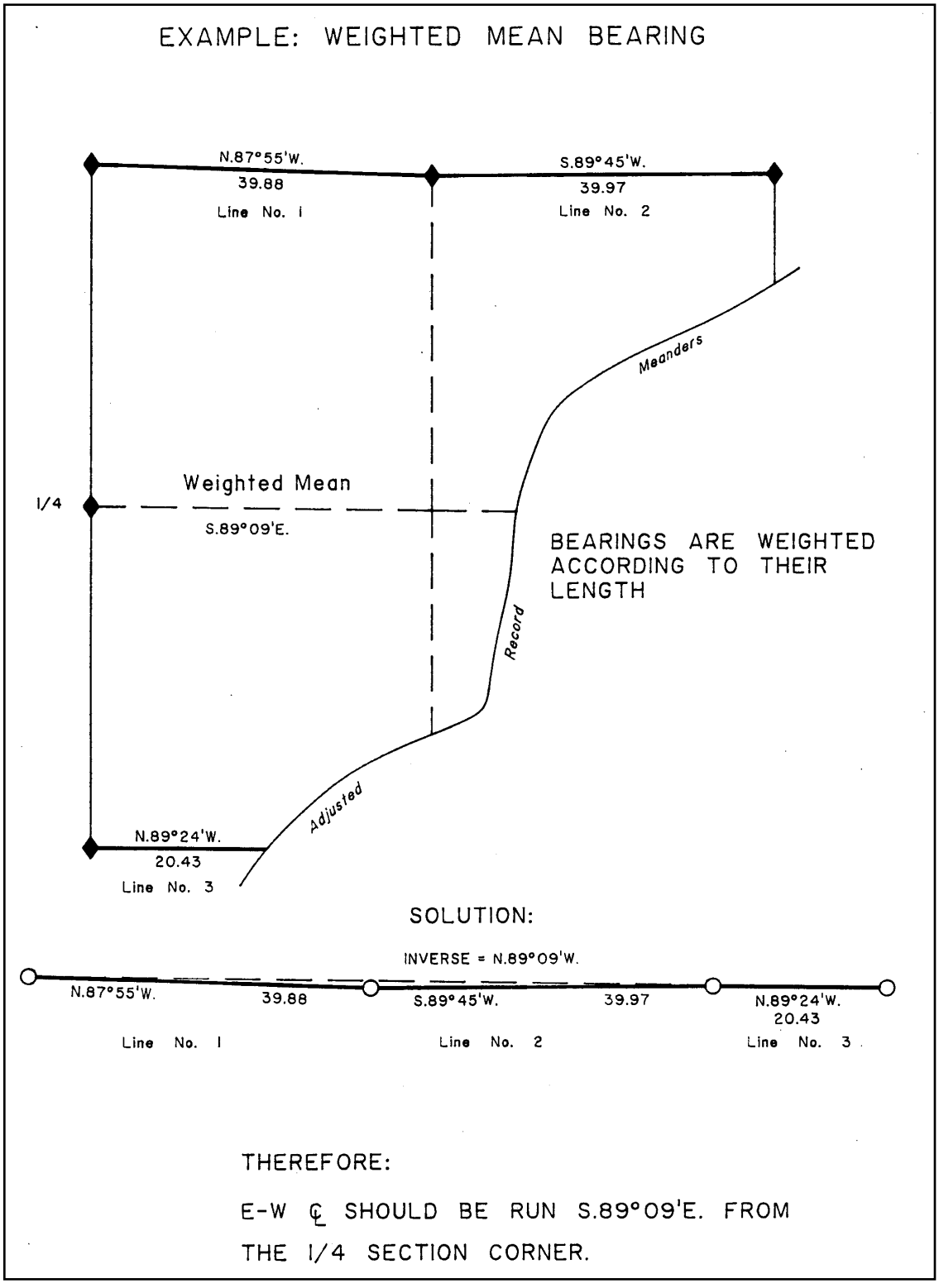


Figure 96

iv. Subdivision of Fractional Quarter Sections

3-90. *The subdivisional lines of fractional quarter sections will be run from properly established quarter-quarter or sixteenth-section corners, with courses governed by the conditions represented upon the official plat, to the lake, water-course, reservation, or other irregular boundary which renders such sections fractional.*

3-91. *Reasonable discrepancies between former and new measurements may generally be expected when retracing the section boundaries. The shortage or surplus is distributed by proportion in establishing a sixteenth-section corner. For example: The length of the line from the quarter-section corner on the west boundary of section 2 to the north line of the township, by the official survey was reported as 43.40 chains, and by the county surveyor's measurement was found to be 42.90 chains. The distance which the sixteenth-section corner should be located north of the quarter-section corner would be determined by proportion as follows: As 43.40 chains, the official measurement of the whole distance, is to 42.90 chains, the county surveyor's measurement of the same distance, so is 20 chains, original measurement, to 19.77 chains by the county surveyor's measurement. By proportionate measurement in this case the sixteenth-section corner should be set at 19.77 chains north of the quarter-section corner, instead of 20 chains north of said corner, as presented on the official plat. In this manner the discrepancies between original and new measurements are equitably distributed.*

v. Seeley Lake

Combined Survey Record
from the BLM Casebook

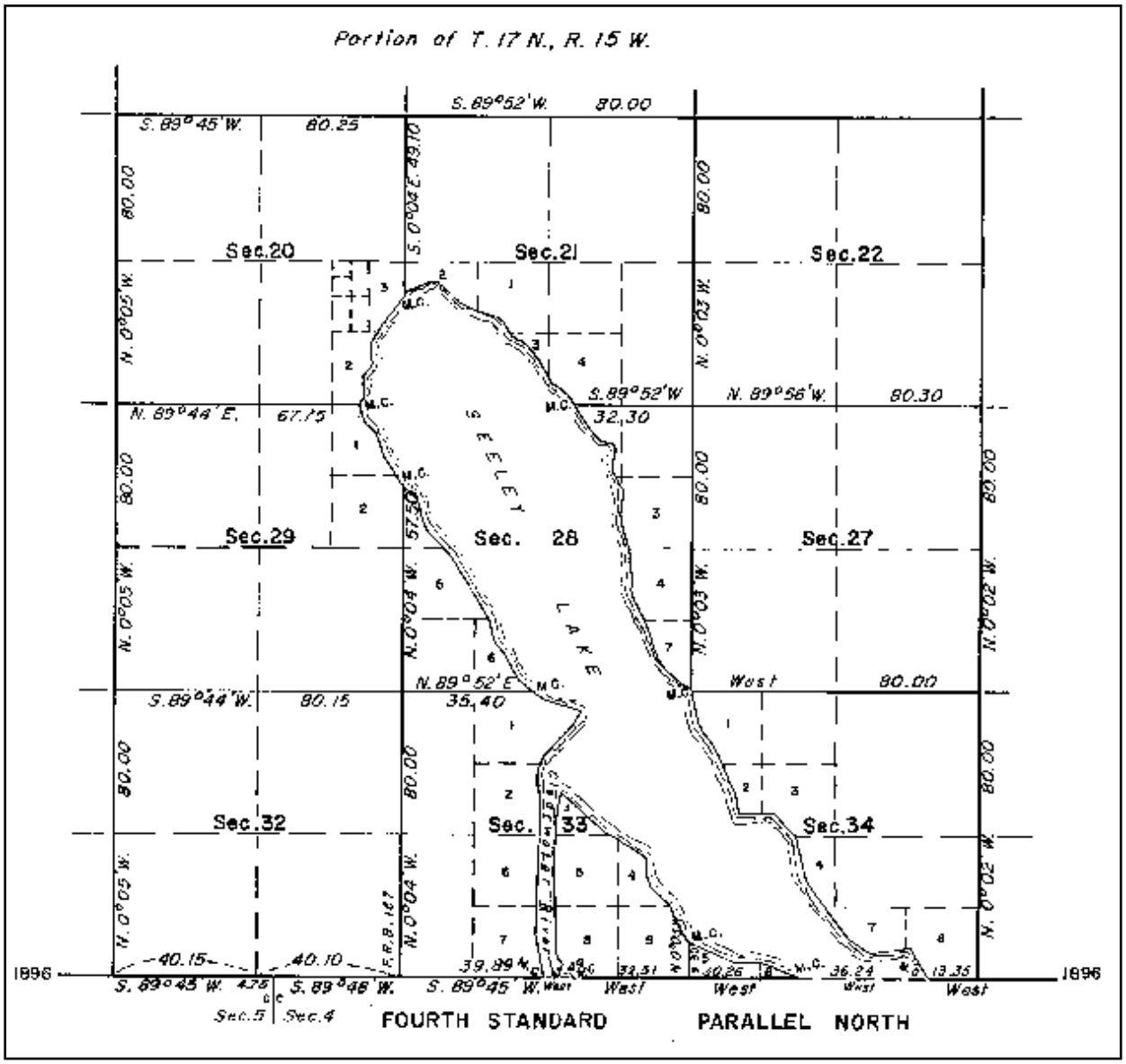


Figure 97

Seeley Lake - Section 20

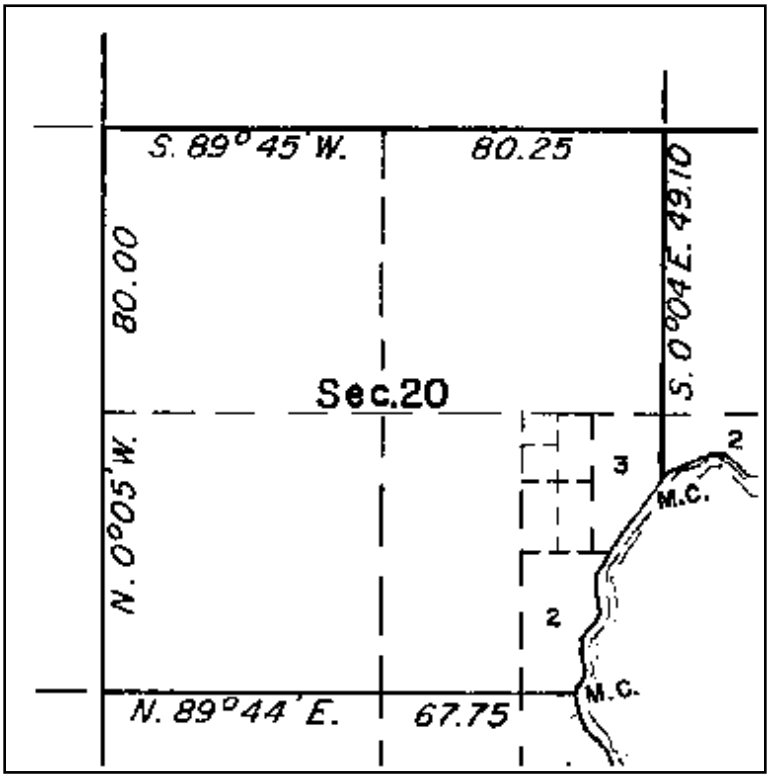


Figure 98

In section 20, the record meanders were retraced and closing error adjusted by the broken boundary method (compass rule.) The centerlines of the section and centerlines of the NE¼, SW¼ and NW¼ were surveyed between opposite corners in the normal procedure. The N-S centerline of the SE¼ was surveyed normally. The E-W centerline of the SE¼ was surveyed easterly on a mean bearing between the E-W centerline of the section and easterly portion on the south boundary of the section and terminated at a special meander corner on the adjusted original meander line. All minor subdivisional lines were run on calculated courses and distances. All 1/16 section corners were monumented. Only necessary minor subdivision corners were monumented.

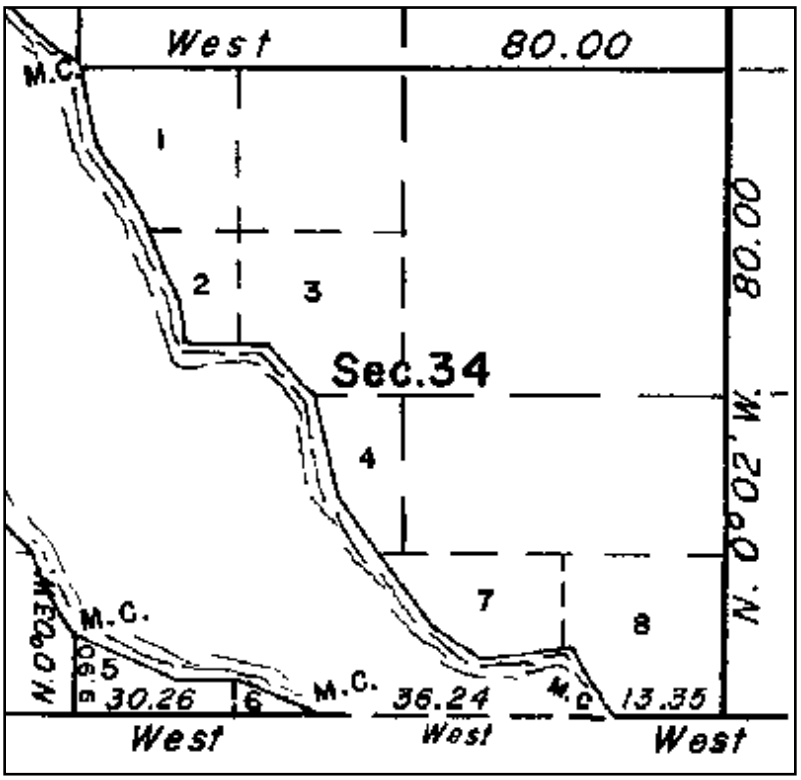


Figure 99

The N-S centerline of section 34 was surveyed southerly on a bearing parallel to the mean bearing of the east boundary of the section. The E-W centerline was surveyed westerly on a bearing which was a mean between the mean bearings of the north and south boundaries of the section. The center ¼ section corner was established at the intersection of the centerlines.

Based on the resurvey of the south, east and north boundaries of section 34, the record meanders were adjusted by calculation, using the compass rule and the first two calculated courses run on the ground.

The N-S centerline of the SE¼ of section 34 was surveyed southerly on a mean bearing between the N-S centerline and the south half of the east boundary of the section to an intersection with the calculated adjusted meander line, where a special meander corner was established.

The E-W centerline of the NE¼ of section 34 was surveyed on a connecting course.

Seeley Lake - Section 33

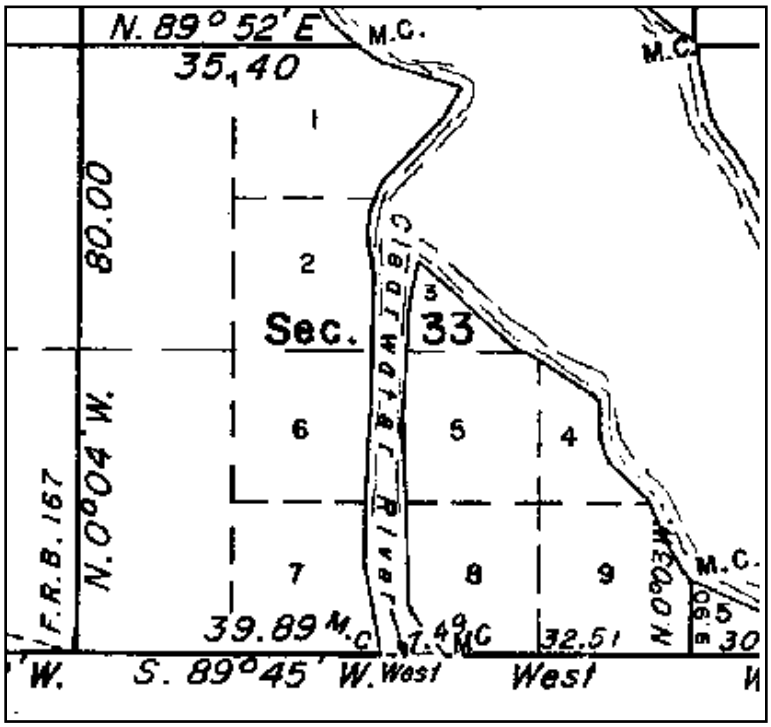


Figure 100

In section 33, all of lots 1 thru 9 are in the National Forest. The portion of the Standard Parallel between Seeley Lake and the Clearwater River was not resurveyed, nor was the short line between sections 33 and 34. Section 33 has only one ¼ section corner.

The E-W centerline of section 33 was surveyed easterly on a mean bearing between the controlling north and south boundaries of the section, with the C-W 1/16 section corner established at a mean distance. The N-S centerlines of the SW¼ and NW¼ were then surveyed, resulting in bearings which were (coincidentally) parallel to the west boundary of the section.

The E-W centerlines of the NW¼ and SW¼ sections were surveyed on mean bearings, easterly to intersections with the N-S centerlines of those ¼ sections and the NW 1/16 and SW 1/16 section corners established. The minor subdivision-of-section lines were surveyed on connecting courses or calculated courses and distances.

vi. Fractional Sections from the BLM Sample Plat

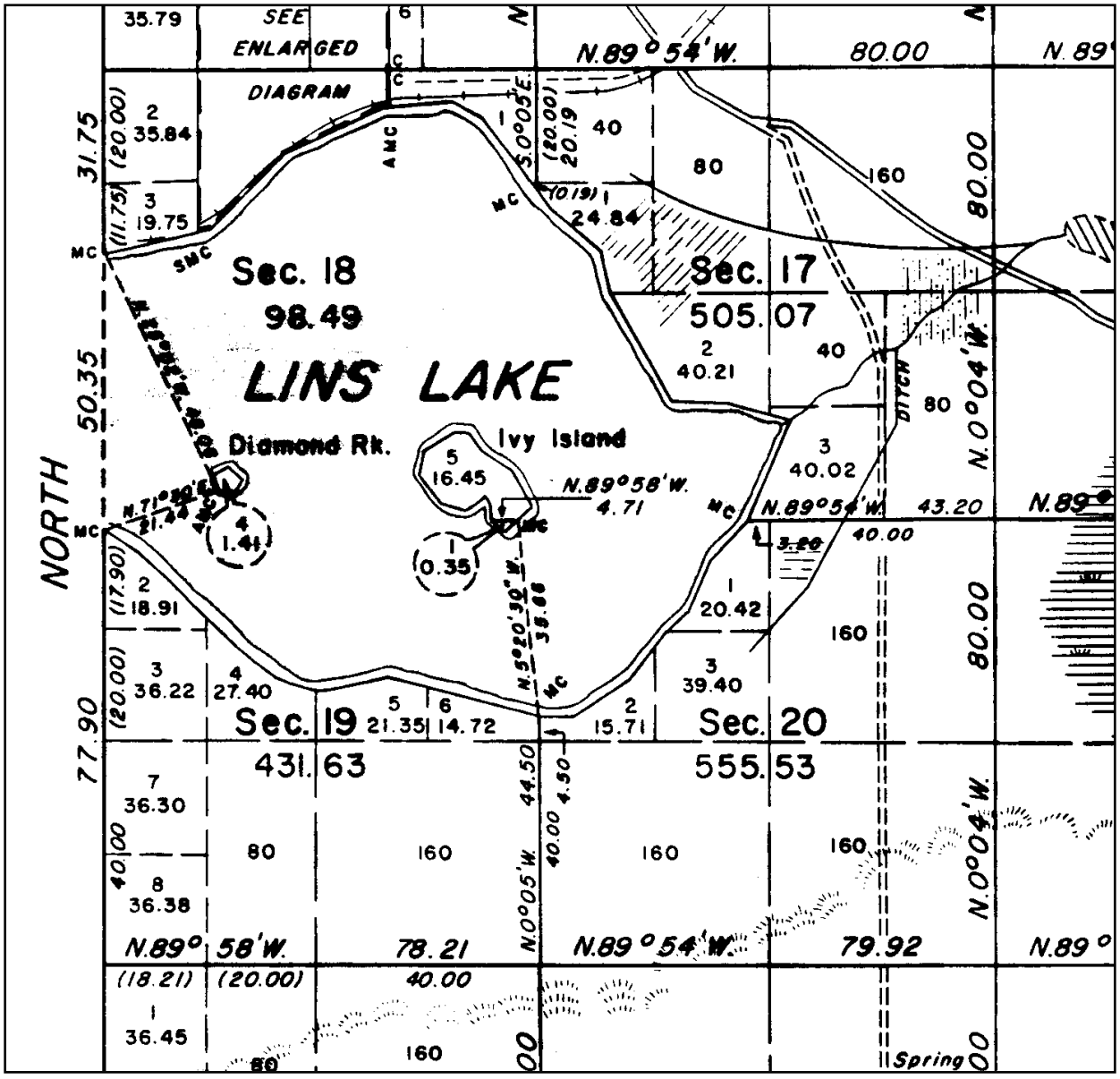


Figure 101

More Fractional Sections from the BLM Sample Plat

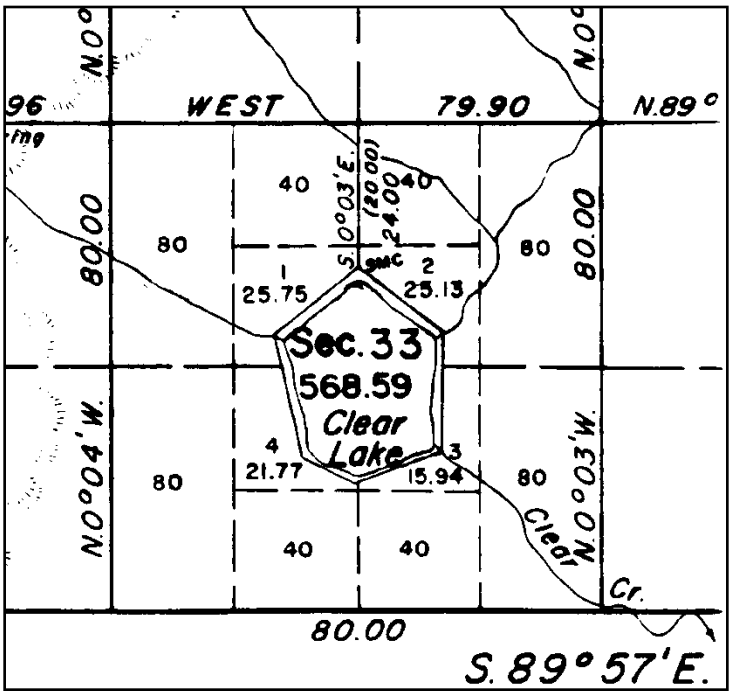


Figure 102

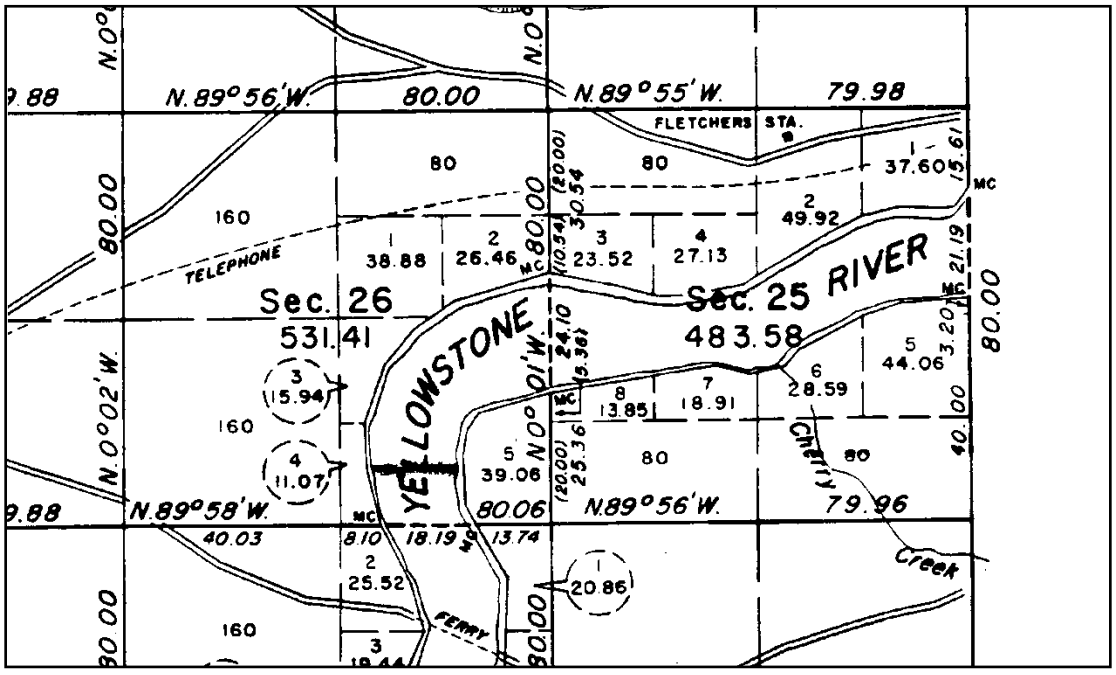


Figure 103

BLM Sample Plat Fractional Section Subdivision Questions

1. What is the bearing of the east-west centerline of Section 17?
   Answer: Weighted mean between the north and south lines of the section.

2. What is the bearing of the north-south centerline of Section 17?
   Answer: Straight line between north and south quarter corners.

3. What is the bearing of the north-south centerline of Section 19?
   Answer: Parallel to the mean east boundary of the section. The irregularity in acreage caused be error of survey and convergence of meridians is placed in the Lots along the township exterior.

4. What is the bearing of the line between Lots 2 and 3 of Section 19?
   Answer: Parallel to the east west centerline of the section.

5. What is the bearing of the north-south centerline of Section 33?
   Answer: The north part is a straight line between the north quarter corner and the special meander corner on Clear Lake. The south part is on a straight line between the special meander corner and the south quarter corner.

6. What is the bearing of the east-west centerline of Section 26?
   Answer: There are at least two answers to the question.
   1. The Oregon State Office of the BLM would consider the section not to be fractional for the purpose of section subdivision. The entire east line of the section was measured and the only reason the east 1/4 corner was not set was because it fell in the river. The position of the east 1/4 corner should be calculated at a single proportion position between meander corners and the east-west centerline of the section should be a straight line between the west 1/4 corner and the calculated east 1/4 corner.
   2. The other answer relies on federal law. The east 1/4 corner was not and could not be fixed, and so the east-west centerline of the section should run from the west 1/4 corner on a weighted mean bearing of the north and south lines of the section.

7. What is the bearing of the line between Lots 3 and 4 of Section 25?
   Answer: Here the answer is even less clear.
   One answer would be a mean bearing between the west line of Lot 3 and the east line of Lot 4..
   Another answer would be to calculate and theoretical center quarter corner, based on the theoretical quarter corner in the Yellowstone River, and then calculate a theoretical center-west 1/16 corner in the river, resulting in an north-south centerline of the northwest quarter of the section which connects opposite 1/16 corners.

vii. Fractional Section 12 not measured across the water

See next page for letter of advice from the BLM.

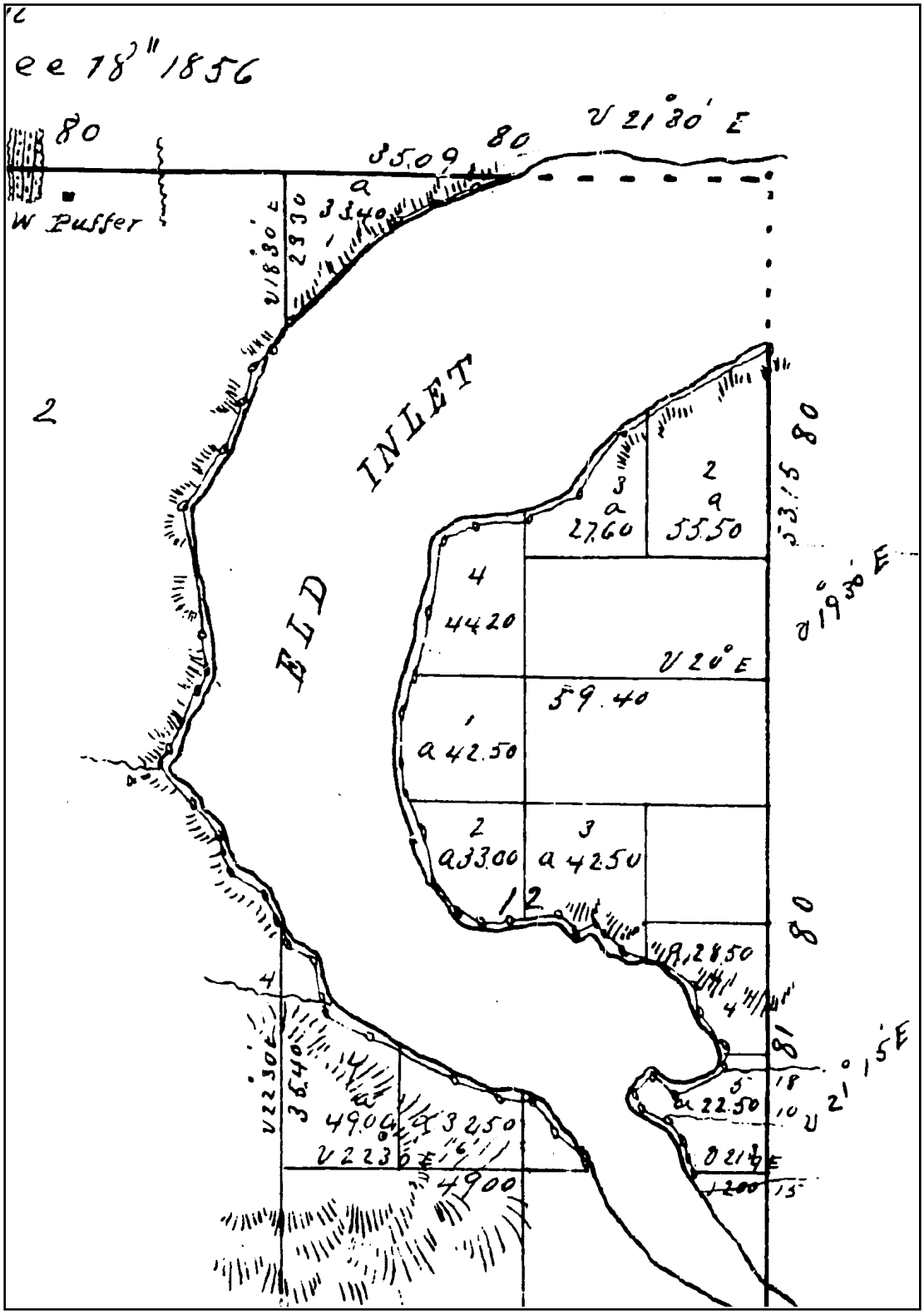


Figure 104

IN REPLY REFER TO:

9600 (942)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

OREGON STATE OFFICE
P.O. Box 2965 (825 NE Multnomah Street)
Portland, Oregon 97208

March 30, 1988

Mr. Gordon H. Grayum
Manke Lumber Co., Inc.
826 Fairmount
Shelton, WA 98584

Dear Mr. Grayum:

Reference is made to your letter dated March 18, 1988, concerning fractional section 12, T. 18 N., R. 3 W., Willamette Meridian, Washington.

We have reviewed the plats and field notes pertaining to this area. Based on this information, we can outline the procedure this office would most likely use if we were involved in initial subdivision of the section, prior to development and improvement.

That portion of section 12 lying west of Eld Inlet would be subdivided separately from the portion of section 12 east of Eld Inlet, because Berry did not tie between meander corners. The north and south center line of the SW ¼ of section 12 (line between lots 6 and 7) would be surveyed northerly from the west 1/16 section corner of sections 12 and 13, on a bearing parallel with the line between sections 11 and 12 to intersection with the adjusted record meanders of the west shore of Eld Inlet.

That portion of section 12 lying east of Eld Inlet would be subdivided as follows:

The north and south center line of the section would be surveyed southerly from the ¼ section corner of sections 1 and 12, on a bearing parallel with the east boundary of the section to intersection with the adjusted record meanders of the easterly shore of Eld Inlet. The east and west center line of the section would be surveyed westerly from the ¼ section corner of sections 7 and 12, on a weighted mean bearing of the north boundary of the section and that portion of the south boundary of the section lying east of Eld Inlet to intersection with the adjusted record meanders of the easterly shore of Eld Inlet.

This letter represents the opinion of this office, based on the official record. Complications which develop in the field, such as excessive distortion or locally established points (which could properly be used as control) could make all or part of the above procedures inapplicable.

It must be noted that this office lacks the authority to instruct private surveyors in their work. While we are willing to discuss procedures and assist in interpreting the official record, our comments and letters are advisory in nature only and should be construed in this manner.

viii. Quarter Corner that falls in a Lake or River

This example is on Lake Sutherland, near Port Angeles. The BLM advised a local surveyor to calculate the east-west centerline based on a theoretical quarter corner calculated in the lake.

Section 20, T30N, R8W, W.M.

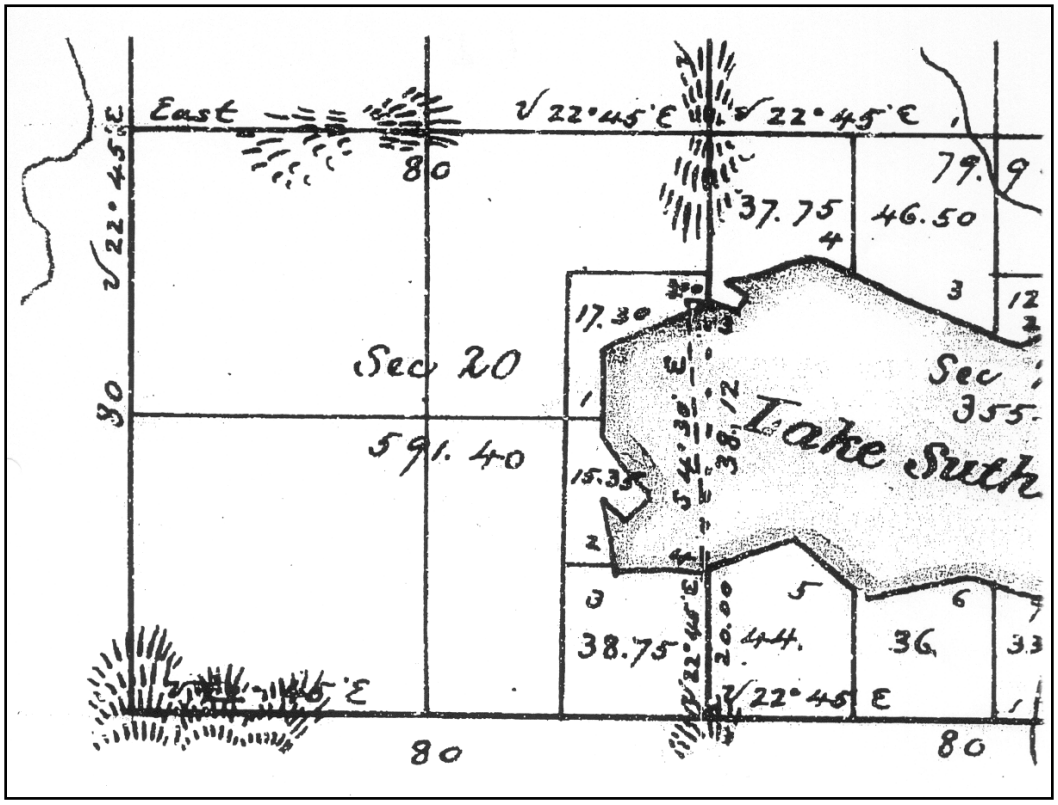


Figure 105

In 1959 a licensed land surveyor asked the BLM for an advisory opinion regarding the subdivision of section 20 and the quarter corner in Lake Sutherland. On the line between sections 20 and 21 both section corners and both meander corners had been found. The BLM responded that they would likely calculate the quarter corner in the lake at a midpoint between section corners, ignoring the found meander corners for proportioning, and use that position to calculate the east-west centerline of section 20. The surveyor followed the BLM advice. In 1963 a second licensed land surveyor used the found meander corners to proportion in quarter corner in the lake, resulting in a significantly different position for the east-west centerline of the section. A dispute ensued between property owners in lots 2 and 3 and in 1966 a Clallam County court case fixed the boundary between the two lots using the 1959 survey.

Fractional sections with a missing quarter corner between existing section corners have been surveyed in several different ways and the following letter from the Oregon State Office of the BLM addresses those issues.

ix. BLM letter on subdividing fractional sections

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Oregon State Office
P.O. Box 2965
Portland, Oregon 97208

IN REPLY REFER TO:

9626 (OR 957)
Sub. of Frac. Secs

June 9, 1997

David Steele, PLS
State Land Survey Coordinator
Washington State DNR
P.O. Box 47060
Olympia, Washington 98504-7060

Dear Mr. Steele:

This is in response to your request for information on the procedures we use when subdividing fractional sections. For the purpose of this letter, we will limit our comments to the technical aspects of original plat interpretation involving fractional sections. Other factors that would normally also be considered such as previous local surveys, private landowner use lines, and unwritten rights will not be part of this discussion.

Section 3-88 of the 1973 Manual addresses the subdivision of fractional sections, but this section of the Manual is brief and somewhat ambiguous. Different interpretations have been applied to the phrases "where opposite corresponding quarter-section corner have not been or cannot be fixed" and for "mean courses." As a result, most BLM field offices have developed their own unofficial policies to supplement the Manual.

The comments and supporting enclosures that follow, should provide you with the general guidelines and procedures that this office uses when subdividing fractional sections in Oregon and Washington. We emphasize the word general because with all the water and reservation boundaries in these two states, there are too many possible scenarios for us to be specific. If in the future you are faced with situations that are not covered by these guidelines, we'd be glad to offer opinions if you so request in writing.

Definition of Fractional Section

There is not a simple way to define a fractional section; maybe that's why the Manual didn't attempt to provide one. We consider a fractional section to be one that has an exterior section corner or 1/4 corner that was not originally established and monumented (fixed) because the position fell within a meandered water body or reservation and/or one that has major portions of the section boundaries not surveyed because of intersecting a meandered body of water or reservation. Fractional sections will have some or all of the subdivision of section lines protracted on the original plat as terminating at the meandered water body or reservation

rather than extending through to the opposite boundary or center line. A fractional section won't have a tie between meander corners, meaning the total distance for the mile won't be returned.

Mean and Parallel Courses

Section 3-88 refers to courses of the subdivision of section lines being run on a mean of the section lines or being surveyed parallel (to one of them). By section lines (boundaries), the Manual means the bearings of the section boundaries as determined by a resurvey. If two opposite section boundaries, or portions of, are extant, then a mean course of the two section boundaries is determined and used in running the section center line (see the diagram on Enclosure "A"). If only one section boundary, or a portion of, is extant then the course of that boundary is used in running the section center line (see Enclosure "B"). Minor subdivision of section lines are surveyed in a similar manner based on corresponding section boundaries and/or section center lines.

This office interprets the term "mean courses" to be weighted means, which are computed in the manner described in Enclosure "A". We feel that a weighted mean should be used, especially when one boundary is much longer than the other, because it weights each course by distance and theoretically creates a more equitable solution. Of course there may be times when errors or blunders exist in the original survey which makes a weighted mean less appropriate.

To further assist in explaining our procedures, we've enclosed examples of actual situations involving fractional and non-fractional sections. The examples have been labeled as Enclosures "C" through "E " and will be referred to accordingly.

Enclosure "C" is from the BLM Casebook, published in 1975. This example is good in that it describes a BLM survey that involved multiple section subdivisions with different situations. This case discusses most aspects of fractional sections including adjusting original meanders, determining courses for the subdivision of section lines, and establishing subdivision of section corners. Note: Where this case states that a "mean" bearing was used, this office would have used a "weighted mean" bearing.

Enclosure "D" is of section 33, T. 39 N., R. 43 E., W.M., Wa. A private surveyor requested our advice for the subdivision of this section. This is a fractional section because the northwest section corner and west 1/4 section corner fall in the river and major portions of the north and west boundaries were not surveyed. The east and west center line is based on a weighted mean bearing of the resurveyed north and south section boundaries. The private surveyor found the original survey to have been performed accurately enough that he could calculate the proportionate position for the center W 1/16 section corner based on the meanders and lot areas. If the original survey had not been accurate enough to determine a proportionate basis, then the normal alternate procedure would have been to establish the center W 1/16 corner at 20 chs. from the center 1/4 corner.

Note: Although the southwest section corner was not needed to subdivide section 33, it does control areas in the township to the south. If this section corner was needed for surveys in sections 4 or 5, it could be established based on the fact that the original survey projected the township line across the water.

Enclosure "E" is of section 33, T. 35 N., R. 9 E., W.M., Wa. A private surveyor requested our advice for the subdivision of this section. He proposed surveying the north and south center line on a mean bearing because the north 1/4 section corner had not been "fixed" in the original survey. We advised that this was an acceptable procedure, but that in this case, he could consider establishing (fixing) the north 1/4 corner at proportionate distance between meander corners because the original surveyor measured across the river. He said that proportioning the 1/4 corner would actually be a better solution because it would result in better equity.

Enclosure "F" is of the original subdivision surveys of T. 17 S., R. 3 E., W.M., Oregon. The subdivisional lines north of the McKenzie River were surveyed in 1874, as shown on the official plat approved November 4, 1875. The subdivisional lines south of the river were surveyed by another surveyor in 1884, as shown on the official plat approved December 30, 1884. The 1884 survey of the partial sections abutting the south side of the river did not tie across the river to the partial sections abutting the north side of the river. Consequently, we consider the sections against the north side of the river to be fractional and independent of the fractional sections against the south side of the river. The subdivision of these fractional sections bordering both sides of the river would be performed using either the weighted mean or parallel methods in accordance with the aforementioned guidelines.

We hope this information satisfies your request and will be helpful in the future. Please don't hesitate to contact us if you have questions or would like for us to review a particular situation that presents different problems than we've addressed here.

Sincerely,

Wayne M. Gardner
Chief, Branch of Geographic Sciences

Enclosures as noted

Enclosure D (referred to in letter from BLM)

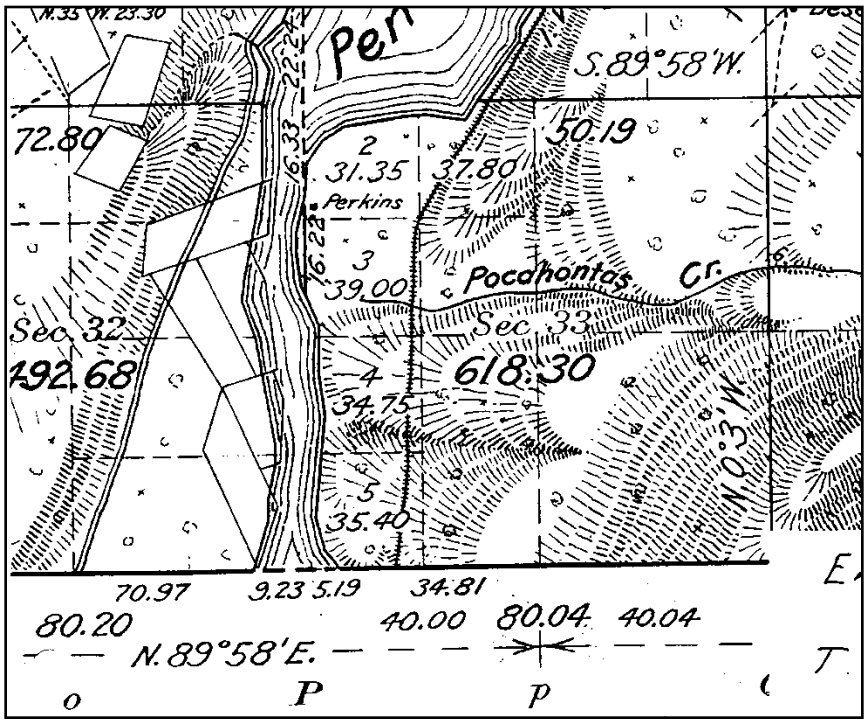


Figure 106

Enclosure E (referred to in letter from BLM)

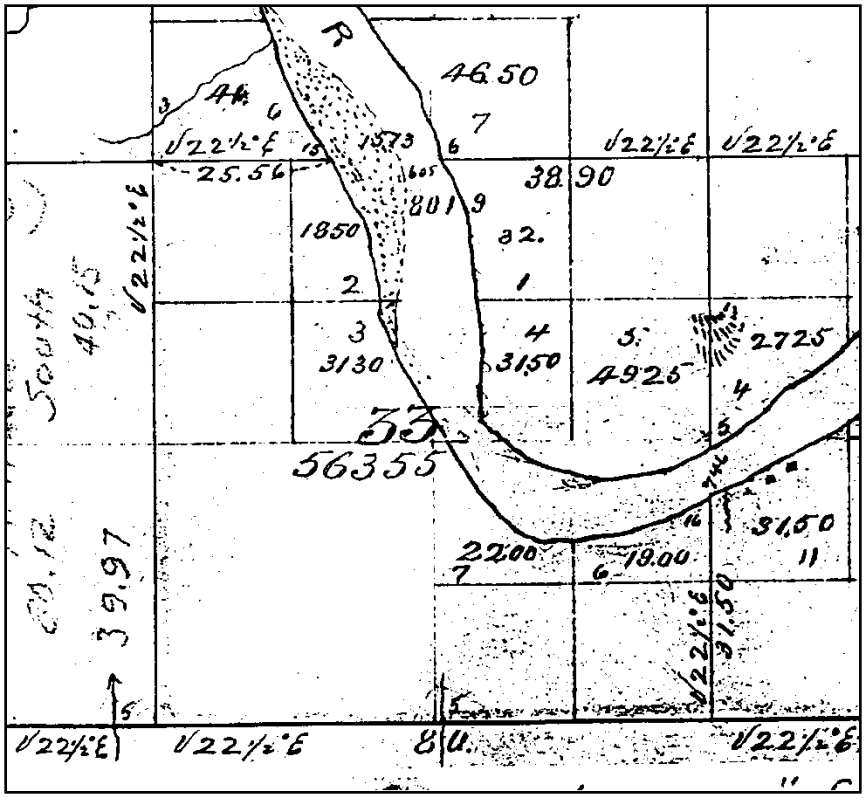


Figure 107

x. Missing Quarter Corner Question

The question is how to subdivide a section when, in the original survey, all sides have been measured in their entirety and one or more quarter corners are missing because the positions fall in a body of water that makes the section fractional.

Two Options:

1. Survey the section centerline using the fractional section method employing a true, mean or parallel bearing.
2. Survey the section as a normal section by proportioning the quarter corner in the body of water.

Section 11, in Figure 108 below, might provide a clue to the answer. Section 11 is not a fractional section. It has a missing quarter corner in a body of water that was not meandered. The north-south centerline cannot be surveyed on a mean bearing because the section is not fractional, having no government lots. It can only be surveyed by proportioning the missing quarter corner. Fractional section subdivision methodologies are not available. The question that this case raises is this: Why would one survey the section differently if the river had been meandered and the section had been fractional?

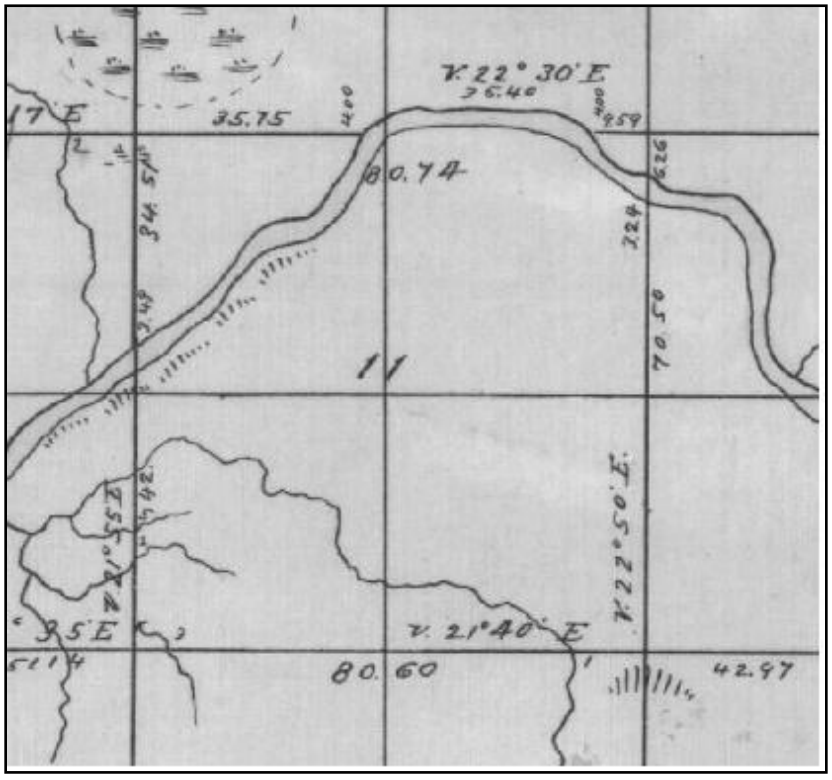
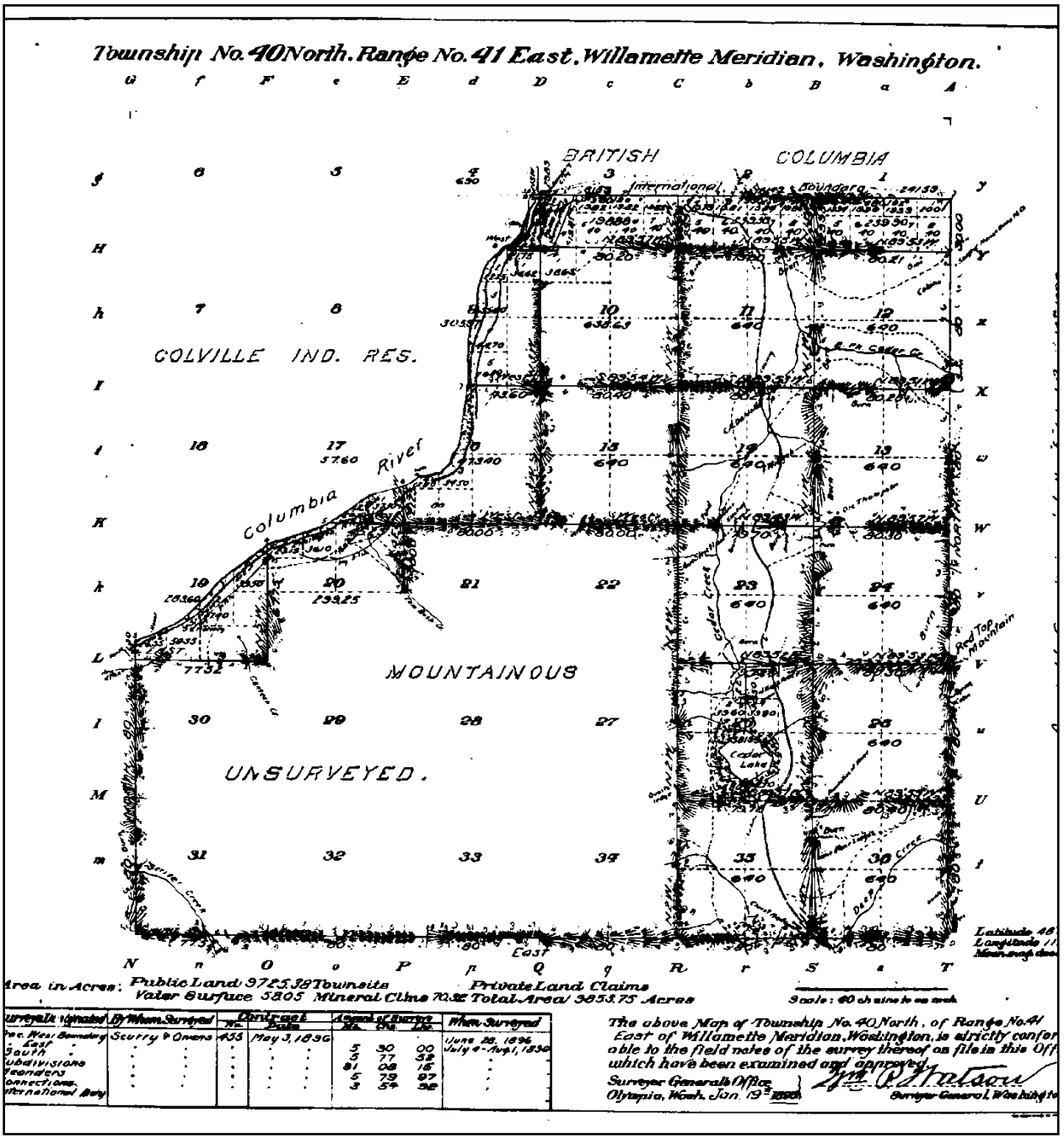


Figure 108

6. Survey of Parts of Sections and Completion Surveys



The following is from the 1973 BLM Manual. In Washington, most surveys of parts of sections and completion surveys were performed under earlier instructions. However, the 1973 instructions have not changed the reasoning and methodology used in previous instructions. Three important considerations in completion surveys are (1) that the integrity of first survey must protected, (2) that, if the previous survey is found to be within limits, the completion survey can be regular, and (3) that, if the previous survey is found to be out of limits, the completion survey will create fractional areas at the interface between the old and the new survey.

SURVEY OF PARTS OF SECTIONS

3-93. In rare cases portions of the section boundaries are impassable or so insecure that acceptable monumentation is impracticable, and yet a need exists for survey of the accessible area. Since rules covering every set of conditions cannot be given, the methods ordinarily are carried in the special instructions.

3-94. The field notes show only the true line courses and distances, the usual topography, the description of monuments, and a description of the difficulties which warranted an elimination of parts of the section or sections.

3-95. To subdivide a partly surveyed section, the remaining subdivision-of-section lines within the surveyed area would be determined by running straight lines between the nearest established control for the sectional center lines. The position for the center quarter-section corner is at the intersection of the center lines, unless previously marked. The remaining interior sixteenth-section corners on the sectional center lines are at midpoints between the exterior quarter-section corners and the center quarter-section corner, except within the sections normally fractional. The center lines of the quarter sections would be completed on a similar plan. In all sections normally fractional the excess or deficiency would be placed in its normal position.

Completion of Partially Surveyed Sections

3-103. In extending fragmentary surveys, first consideration is given to the completion of partially surveyed sections. If outlying portions of sections have been returned as surveyed on the previous plat, it is usually necessary to complete the survey of each section in such a way as to protect acquired rights. The procedure adopted must fix the remaining quarter-section corners in a position which will control the center lines as necessary to retain the form of the original areas within reasonable limits.

3-104. The new quarter-section corners are regarded as reasonably fixed when (1) the alinement does not exceed 21' from a cardinal course and (2) the measurement does not exceed 25 links from 40 chains, or in proportion when the opposite portion of the section boundary was returned as more or less than 40 chains. This concession as to limits is made in

the interests of simplicity where the rectangularity of both old and new surveys can thus be maintained.

3-105. The position of the quarter-section corner on a new opposite boundary is controlled from only one direction if the old opposite distance was made to count from one direction only. If the old opposite distance was made to count from two directions, the position of the new quarter-section corner is controlled from the two directions. The lengths of the two portions of the new line are made proportional to the two parts of the old opposite boundary.

3-106. Given an original survey which is within rectangular limits, the survey of a fractional section is completed on the same plan begun in the original survey. When irregularity is developed, the simplest method of survey will correct irregularities and provide an early resumption of regularity in the new subdivisional lines is adopted. The general rule is that each completed section will have four regular boundaries without offsets, with four governing section corners and four controlling quarter-section corners in such position as to maintain the integrity of the fractional areas shown upon the original plat.

3-107. Modification of the general rule is necessary where completing each of two sections in the above manner would cause an overlap or hiatus. In such a case each section is completed theoretically without regard to the other, and the position of each center line is fixed. The most reasonable position for a common boundary between the two sections is then determined, and the new quarter-section corners are established at points which maintain the center lines in their positions. If the theoretical position for each quarter-section corner falls within 25 links of a common point, with allowance for variance in length of the center line, one corner may be established which will secure maximum regularity in both sections.

3-108. The possible combinations of uncompleted sections are too numerous to discuss fully here. Directions will be given in the special instructions for the cases involved in an assignment, and the surveyor should seek advice from the proper administrative office when irregularities develop. A diagram showing the exact field conditions should always accompany his report.

3-109. A private survey made for the purpose of marking on the ground a theoretical line, platted but not run by the Government, where executed within allowable departure from cardinal course, and relied upon by owner under title passed by the United States in the placing of improvements upon the patented land, will not be disturbed, but it will be adopted by the Government as a boundary for closure of the survey of the adjoining public land. **Algoma Lumber Co.** v. **Kruger**, 50 L.D. 402 (1923).

3-110. The best test of the fitness of a proposed method for the completion of partially surveyed sections is to plat the subdivisional lines by protraction. Thereupon the regular rules for subdivision of sections should be applicable. The position of the new quarter-section corners, established to control the subdivision of the section in question, must be such as to permit the center lines to the opposite original quarter-section corners to be connected in harmony with conditions shown on the original plat, disregarding the effect upon the subdivision of the newly surveyed land. Likewise, the lines connecting the sixteenth-section

corners on the opposite boundaries of a quarter section must conform to the conditions represented on the original plat. When the subdivision-of-section lines are platted, the section is satisfactory if the integrity of the original areas is in no way violated.

3-111. The following guidelines should be followed in platting:

(1) The new areas should be complementary to the original areas by the extension of the subdivision-of-section lines as already protracted upon the original plat, except as poorly shaped lots, or lots of too great or too little area, would result in violation of the regular rules for subdivision of sections.

(2) In the interest of regularity and simplicity of platting, the same meridional limit may be permitted as is ordinarily allowed in latitudinal section lines. A section may be considered regular if its boundaries do not depart more than 21' from a cardinal course in alinement and no more than 25 links from 40 chains in measurement between the section and quarter-section corners. Such regular sections may be subdivided into regular quarter sections and quarter-quarter sections as far as possible. A section having three regular boundary lines may be subdivided in accordance with the usual rules for subdividing sections along the north and west boundaries of a normal township. A section having two adjacent regular boundary lines may be subdivided by the same manner in which section 6 of a normal township is treated. All other sections should be treated as irregular, with subdivision-of-section lines protracted o mid-points on the boundaries of the quarter sections, except as a calculated proportional position for a sixteenth-section corner is made necessary by the showing of the original plat.

(3) All new fractional lots are numbered beginning with the next higher number in the series shown on the previously approved plat, and proceeding in the usual order. The new series may begin with No. 1 if the fractional parts of the original area are not designated by lot number.

Rectangular Limits in the 1973 BLM Manual

BLM Manual
3-34. The amounts by which a section, or its aliquot parts, may vary from the ideal section and still be considered regular are referred to as the rectangular limits :
(1) For alinement, the section’s boundaries must not exceed 21’ from cardinal in any part, nor may the opposite (regular) boundaries of a section vary more than 21’.
(2) For measurement, the distance between regular corners is to be normal according to the plan of survey, with certain allowable adjustments not to exceed 25 links in 40 chains.

Closing within limits is important in a completion survey. If the completion survey can close within limits with the original survey, the completion results in a regular section. If not, the completion results in government lots being created to contain the irregular areas. See page 102 for a list of rectangular limits in various GLO and BLM manuals.

Figure 109 and Figure 110 below illustrate the significance of closing within limits. Figure 109 is the first GLO Survey, in 1884, in T39N, R4E. Note that Sections 3 and 10 are partial sections. Only the NW1/4 of Section 3 exists and only the SW1/4 of Section 10 exists.

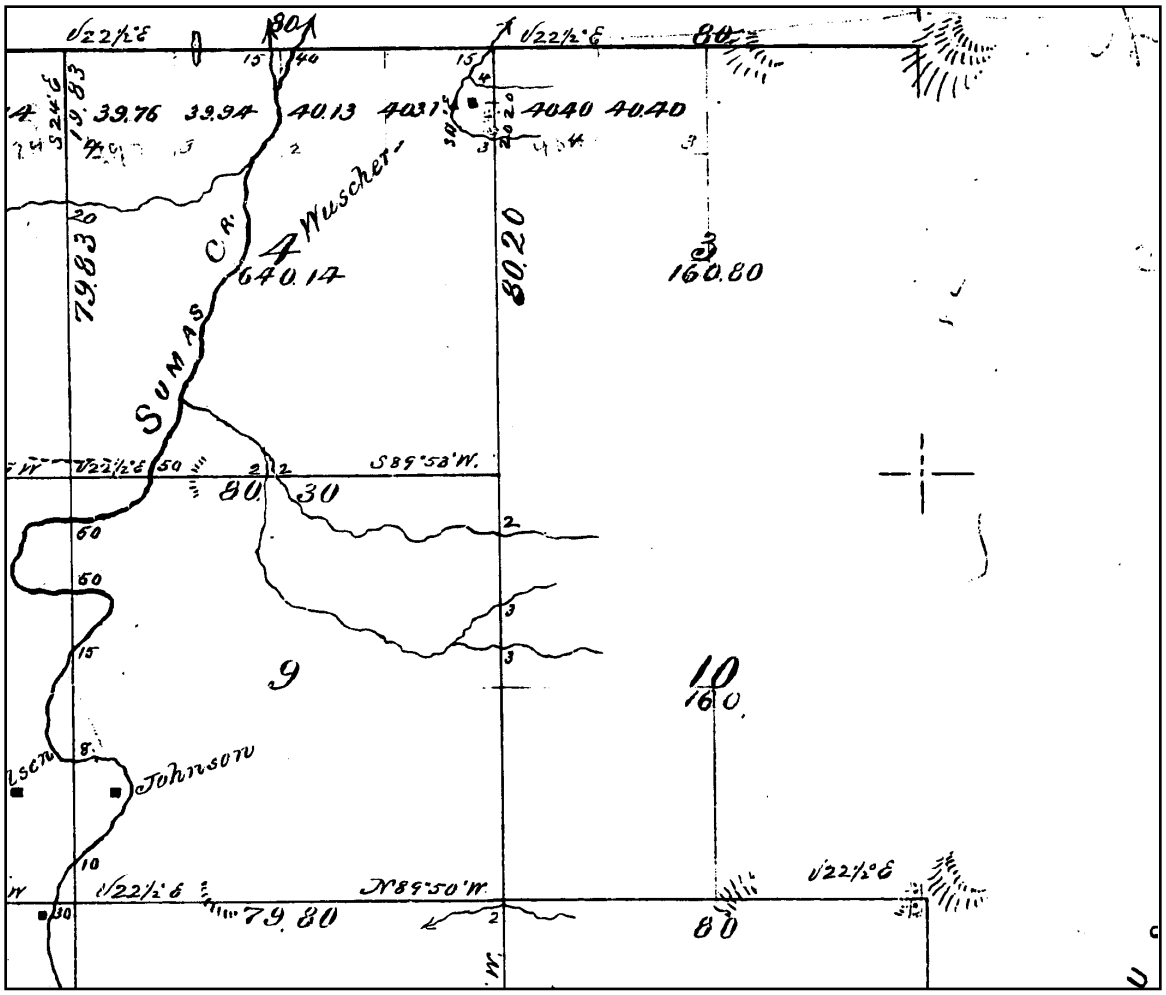


Figure 109

Figure 110 is the completion survey, executed in 1895. The question is how to subdivide Sections 3 and 10.

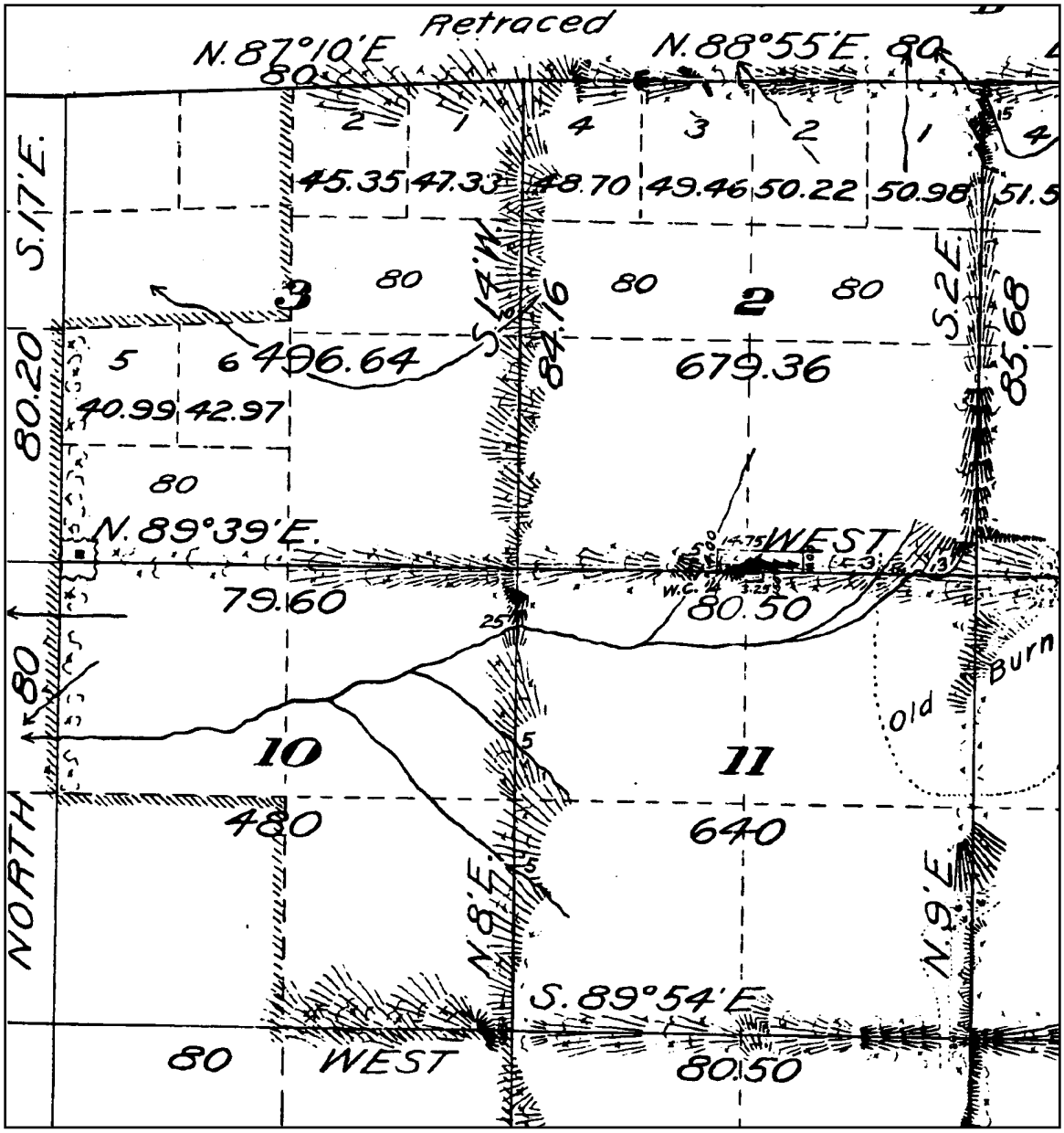


Figure 110

The following letter of advice from the BLM comparing the completion of sections 3 and 10 above, illustrates the importance of rectangular limits in completion surveys.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Oregon State Office
P.O. Box 2965
Portland, Oregon 97208

IN REPLY REFER TO:

9626 (OR 957)
Whatcom Co., Wa.

August 20, 1997

Gary S. Herrick, PLS
Washington State DNR
Northwest Region
919 N. Township St.
Sedro-Woolley, Washington 98284-9333

NORTHWEST REGION DNR
REGION
RID
RUS ADMIN
AUG 28 1997
HRA
ACCT
CIC
INVESTGTR
ARM STATE
PROPRGR
ENG
TRS
TRAN & AQ
UPLANDS
SOILS
METCR
SECTTY
PUBLISH
BAKER
CASCADE
ORCA

Dear Mr. Herrick:

This is in reply to your letter dated July 31, 1997 (received August 13, 1997), concerning procedure for subdividing section 10, T. 39 N., R. 4 E., Willamette Meridian, Washington.

The original areas within section 10 were returned from two separate surveys; the SW 1/4 from the 1884 survey by Iverson and the remainder of the section from the 1895 survey by Galbraith. Galbraith closed within limits against the first survey and therefore he was able to establish the 1/4 section corners on the north and east boundaries at positions that protected the previously returned areas by use of a normal (straight center lines) subdivision of section 10.

Contrary to the normal subdivision of section 10, is section 3. In section 3, Galbraith could not close within limits against the first survey and consequently had to retrace the north boundary. Galbraith's lotting shows that the southeast corner of the NW 1/4 would be established at the intersection of parallel lines to protect the previously returned areas. Galbraith's plat shows the areas returned from his survey are based on a second center 1/4 corner position.

We hope this information is helpful.

Sincerely,

Wayne M. Gardner
Chief, Branch of Geographic Sciences

Below is a completion survey resulting in two center quarter corners and presenting a challenge in calculating parenthetical distances.

Section 20, T40N, R41W, W.M.

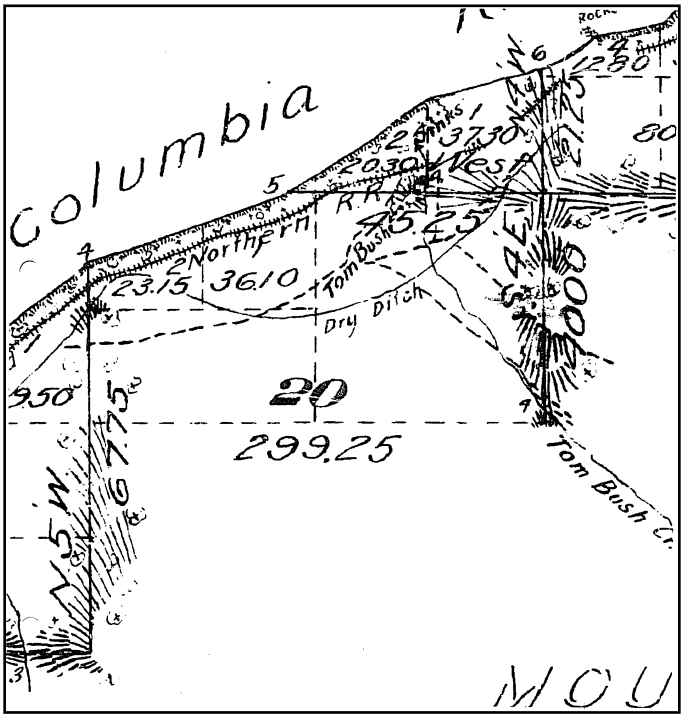


Figure 112

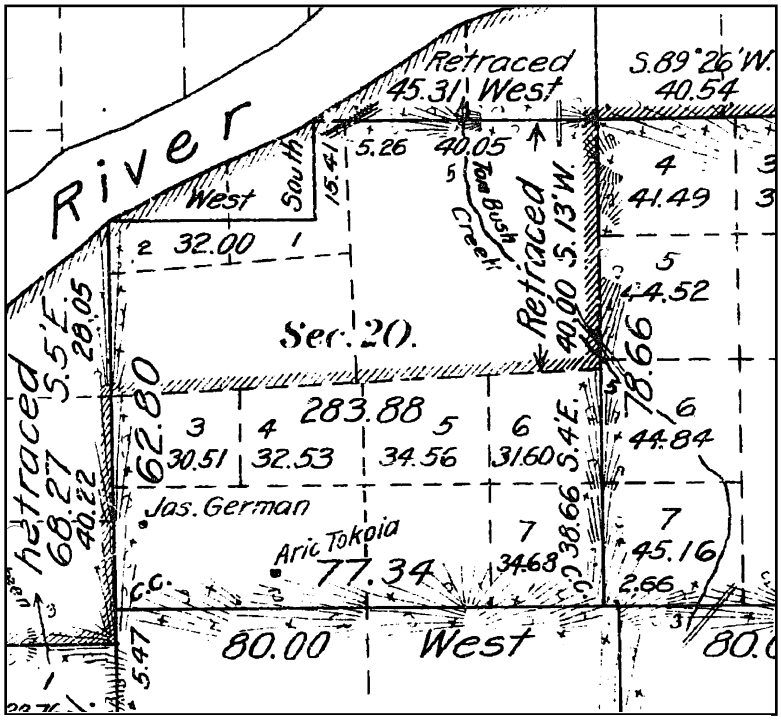


Figure 111

The methodology of the 1894 manual works to determine the parenthetical distances. It should be noted that the areas of lots created in completion surveys were sometimes scaled, which makes the areas difficult to use for computing parenthetical distances.

Parenthetical Distances - South Half of Section 20

14.75 Lot 3 30.51 acres 15.761 20	Lot 4 32.53 acres 16.772 20	Lot 5 34.56 acres 17.783 20	Lot 6 31.60 acres 18.66 17.34
20 40	20	20 20	Lot 7 34.68 acres 20 17.34

Distances calculated per 1894 BLM Manual

$$\frac{18.66 - 14.75}{77.34} = \frac{q}{60} \qquad q = 3.03336$$

$14.75 + 1/3q = 15.761$

$14.75 + 2/3q = 16.772$

$14.75 + q = 17.783$

Acreage Calculations

$14.75 + 15.761 = 30.51$

$15.761 + 16.772 = 32.53$

$16.772 + 17.783 = 34.56$

$$\frac{\frac{17.783 + 18.66}{2} \times 17.34}{10} = 31.60$$

$17.34 + 17.34 = 34.68$

Another way to get distance to CS 1/16
(only works when lots are 20 chains wide)

$$\frac{32.53 + 34.56}{4} = 16.772$$

Figure 113

7. Subdivision by Protraction and Subdivision by Survey

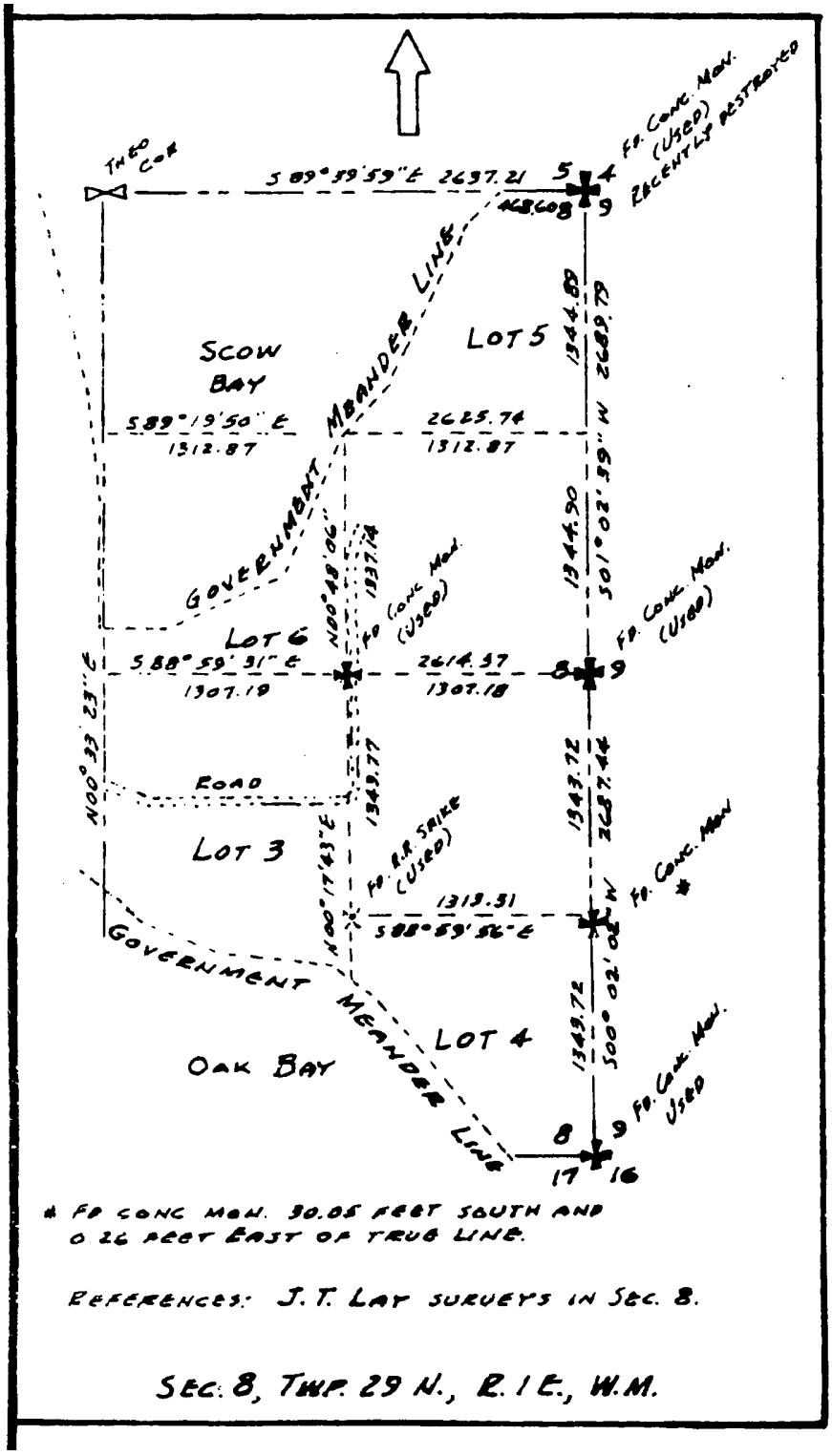


Figure 114

The separate and different instructions for subdivisions by protraction and subdivisions by survey can cause confusion.

DEFINITIONS
SUBDIVISION BY PROTRACTION

Webster's New World Dictionary: "**protract** ... to draw to scale;using a protractor and scale"

3-74. ... The sections are not subdivided in the field by Bureau of Land Management cadastral surveyors unless provision is made in the special instructions, but certain subdivision-of-section lines are always protracted upon the official plat.

3-77. Upon the plat of all regular sections the boundaries of the quarter sections are shown by broken straight lines connecting the opposite quarter-section corners. The sections bordering the north or west boundary of a normal township, excepting section 6, are further subdivided by protraction into parts containing two regular half-quarter sections and four lots.

3-79. Sections which are invaded by meanderable bodies of water, or by approved claims at variance with the regular legal subdivisions, are subdivided by protraction into regular and fractional parts as may be necessary to form a suitable basis for the administration of the public lands remaining undisposed of, and to describe the latter separately from the segregated areas.

SUBDIVISION BY SURVEY

3-85. The rules for subdivision of sections by survey are based on the laws governing the survey of the public lands. Some cases arise, however, which are not covered by these rules and require the advice of the Bureau of Land Management. The letter of inquiry should contain a description of the particular tract or corner, with reference to township, range, and section of the public surveys, together with a diagram showing conditions found.

CONFLICT BETWEEN 3-80 AND 3-88

SUBDIVISION BY PROTRACTION

3-80. ... In the case of a section whose boundary lines are in part within the limits of a meanderable body of water, or within the boundaries of a private claim, t*he fractional section lines are completed in theory*, and the protracted position of the subdivision-of-section lines is controlled by the theoretical points so determined.

SUBDIVISION BY SURVEY

3-88. ... Hence, in order to carry out the spirit of the law, it will be necessary in running the center lines through fractional sections *to adopt mean courses* where the section lines are not on due cardinal, *or to run parallel* to the east, south, west, or north boundary of the section, as conditions may require, where there is no opposite section line.

Resolution of the Conflict between
Section Subdivision by Protraction and Section Subdivision by Survey

A look at the introductory remarks to the respective sections in the BLM Manual is revealing.

Subdivision by Protraction
3-77. Upon the plat of all regular sections the boundaries of the quarter sections are shown by...

Subdivision by Survey
3-85. The rules for subdivision of sections by survey are based on the laws governing the survey of the public lands.

"Subdivision by Protraction" is the method for the drafting of a township plat. There is no basis in law for applying the methodology to a field survey.

"Subdivision by Survey" is the method, based on federal statutes, for establishing on the ground boundaries of sections and parts of sections.

An Example where the distinction between
Subdivision by Protraction and
Subdivision by Survey is important.

On following page is a letter from the BLM suggesting subdivision methodology. The letter makes is clear that “subdivision by survey” requires the use of parallel and mean bearings. Theoretical positions should not be computed in the water for purpose of determining the directions of subdivisional lines.

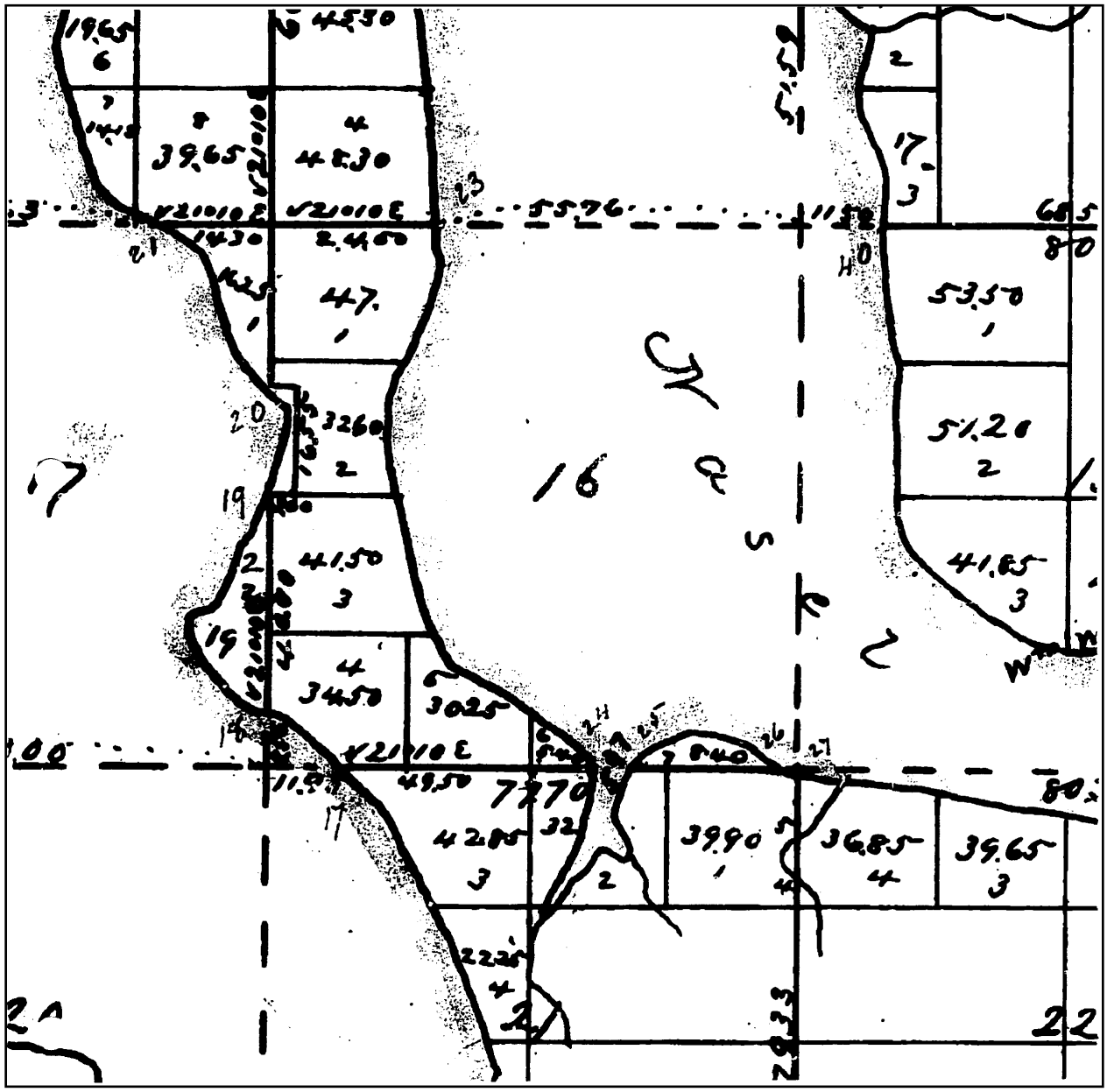


Figure 115

IN REPLY REFER TO:

United States Department of the Interior

9641 (942)

BUREAU OF LAND MANAGEMENT
OREGON STATE OFFICE
825 NE Multnomah Street
P.O. Box 2965
Portland, Oregon 97208

RECEIVED BY
DEPARTMENT OF NATURAL RESOURCES
AUG 23 1984
DIVISION OF ENGINEERING SERVICES
OLYMPIA, WA.

August 21, 1984

This is in response to your letter dated June 5, 1984, concerning the resurvey and subdivision of section 16, T. 11 N., R. 10 W., Willamette Meridian, Washington.

Your letter makes no mention of surveys subsequent to the original survey by Gile in 1874. Therefore, this reply is based on the assumption that there have been no other surveys in section 16. The opinions expressed herein should not be construed as instructions to you; rather they are opinions on how this office would reestablish the lost corners and subdivide section 16.

It appears Gile's measurements by triangulation have a significant amount of error. However, your measurements between found original corners indicate his chaining was good. He actually chained out to several of the corners which fell on the tidelands including the point for the corner of sections 16, 17, 20, and 21 where he set a flag to use for his triangulation to the south and west. Using double proportion to reestablish the corner point will put a considerable amount of distortion in the lines going north and east, distortion that undoubtably was not in the original survey. Therefore, we feel the best method of reestablishing the point for the corner of sections 16, 17, 20, and 21 is by two point control at record departure from the found meander corner between sections 16 and 21, and at record latitude from the found meander corner between sections 16 and 17. This would leave some distortion, but we feel this method best protects the original survey.

The most easterly meander corner of sections 16 and ~~17~~ 21 was originally established as a terminal meander corner, no tie was made to the corner of sections 15, 16, 21, and 22. Therefore, the two meander corners east of the found original meander corner of sections 16 and 21 should be reestablished at record bearing and distance from the found meander corner (Manual, Section 5-45).

The lost ¼ section corner of sections 16 and 21 should be reestablished by single proportion between the reestablished point for the corner of sections 16, 17, 20, and 21, and the found original meander corner of sections 16 and 21. The lost ¼ section corner of sections 16 and 17 should be reestablished by single proportion between the found original meander corners of sections 16 and 17. The 1/16 section corners on the section lines should be at proportionate position between the nearest found original or reestablished corners.

The section should be subdivided in the manner described in Section 3-88 of the Manual, "Subdivision of Fractional Sections". The north and south subdivisional lines should be run parallel to the mean bearing of the west boundary of the section. The east and west subdivisional lines should be run on a weighted mean bearing of the north and south boundaries. (See enclosed example.)

The methods described in this response may or may not be applicable to similar surveys, but appear to best restore the original survey in this situation. We hope this information will be helpful. If we can be of further assistance, please feel free to contact us.

Sincerely,

William W. Glenn

William W. Glenn
Chief, Branch of Cadastral Survey